

The
PAN-PACIFIC
ENTOMOLOGIST

Volume 68

April 1992

Number 2



Published by the **PACIFIC COAST ENTOMOLOGICAL SOCIETY**
in cooperation with **THE CALIFORNIA ACADEMY OF SCIENCES**

(ISSN 0031-0603)

The Pan-Pacific Entomologist

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THE PAN-PACIFIC ENTOMOLOGIST (ISSN 0031-0603) is published quarterly by the Pacific Coast Entomological Society, c/o California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118-4599. Second-class postage is paid at San Francisco, CA and additional mailing offices. Postmaster: Send address changes to the Pacific Coast Entomological Society, c/o California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118-4599.

This issue mailed 14 May 1992

The Pan-Pacific Entomologist (ISSN 0031-0603)
PRINTED BY THE ALLEN PRESS, INC., LAWRENCE, KANSAS 66044, U.S.A.

THIS PUBLICATION IS PRINTED ON ACID-FREE PAPER.

REVISION OF THE SPIDER BEETLE GENUS *NIPTUS* IN NORTH AMERICA, INCLUDING NEW CAVE AND PHOLEOPHILE SPECIES (COLEOPTERA: PTINIDAE)

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Abstract.—The genus *Niptus* is revised for North America. Four species of *Niptus* Boieldieu (*N. giulianii* NEW SPECIES, *N. neotomae* NEW SPECIES, *N. sleeperi* NEW SPECIES, and *N. arcanus* NEW SPECIES) are described from the Great Basin area, southwestern Arizona, the cape mountain region of Baja California, Mexico, and a California cave, respectively. Notes on the biology of *Niptus* species, as well as *Ptinus clavipes*, are presented. A key is provided to the species of *Niptus* found in North America. Phylogenetic considerations among *Niptus*, *Pseudeurostus*, and *Eurostus* are discussed. Habitat conservation is stressed for species restricted to single cave localities.

Key Words.—Insecta, Coleoptera, Ptinidae, *Niptus*, southwest United States, Mexico, biology, caves

As a result of improved collecting techniques, such as overnight pitfall traps or longer duration ethylene glycol (antifreeze) traps, and greater accessibility to previously difficult to reach places, numerous specimens of small apterous beetles are now available in collections. Most larval and adult Ptinidae feed on dried plant and animal substances. Others have been recorded from dung. Many are associated with mammals or birds and are often found in caves. Their biology, including rearing methods of economically important species, is adequately covered by Howe (1959).

One species, *Niptus hololeucus* (Faldermann), a stored product pest, is widely distributed in the northern United States. *Niptus kelleri* (Brown) and *N. hilleri* Reitter have previously been placed in the genus *Pseudeurostus*. One of these, *N. hilleri*, is distributed widely, also in stored products (see Brown 1959: 629). *Niptus kelleri*, known only from the type locality, was not examined.

Because all genera of ptinids are flightless (except for certain *Ptinus*), the method found most effective in capturing pholeophilic Ptinidae is the use of numerous dry plastic "punch cup" containers as pit traps, especially near, or at, the entrance to rodent burrows. These traps are set in the late afternoon and collected early the next morning. This permits collection of live adult specimens for rearing and provides additional biological information (substrate type, etc.). Adults are also collected at night with the use of headlamps or lanterns to illuminate surface areas.

In 1978-1979, a year-long trapping survey of the Coleoptera of Mitchell Caverns was conducted using ethylene glycol pitfall traps (Aalbu 1990). Mitchell Caverns are located on the eastern slopes of the Providence Mountains (San Bernardino County), California. A new species of *Niptus* was found to be endemic to one cave.

Abbreviations.—The following abbreviations are used to denote the institutions that loaned material: CASC, California Academy of Sciences, San Francisco,

California; CISC, University of California, Berkeley, California; CNCI, Canadian National Collection, Ottawa, Ontario, Canada; CSLB, California State University, Long Beach; FMNH, Field Museum of Natural History, Chicago, Illinois; KWBC, Kirby W. Brown Collection, Stockton, California; MCZC, Harvard University Museum of Comparative Zoology, Cambridge, Massachusetts; OSUC, The Ohio State University, Columbus, Ohio; SDMC, San Diego Museum of Natural History, California; USNM, United States National Museum, Washington D.C.; UAIC, University of Arizona, Tucson.

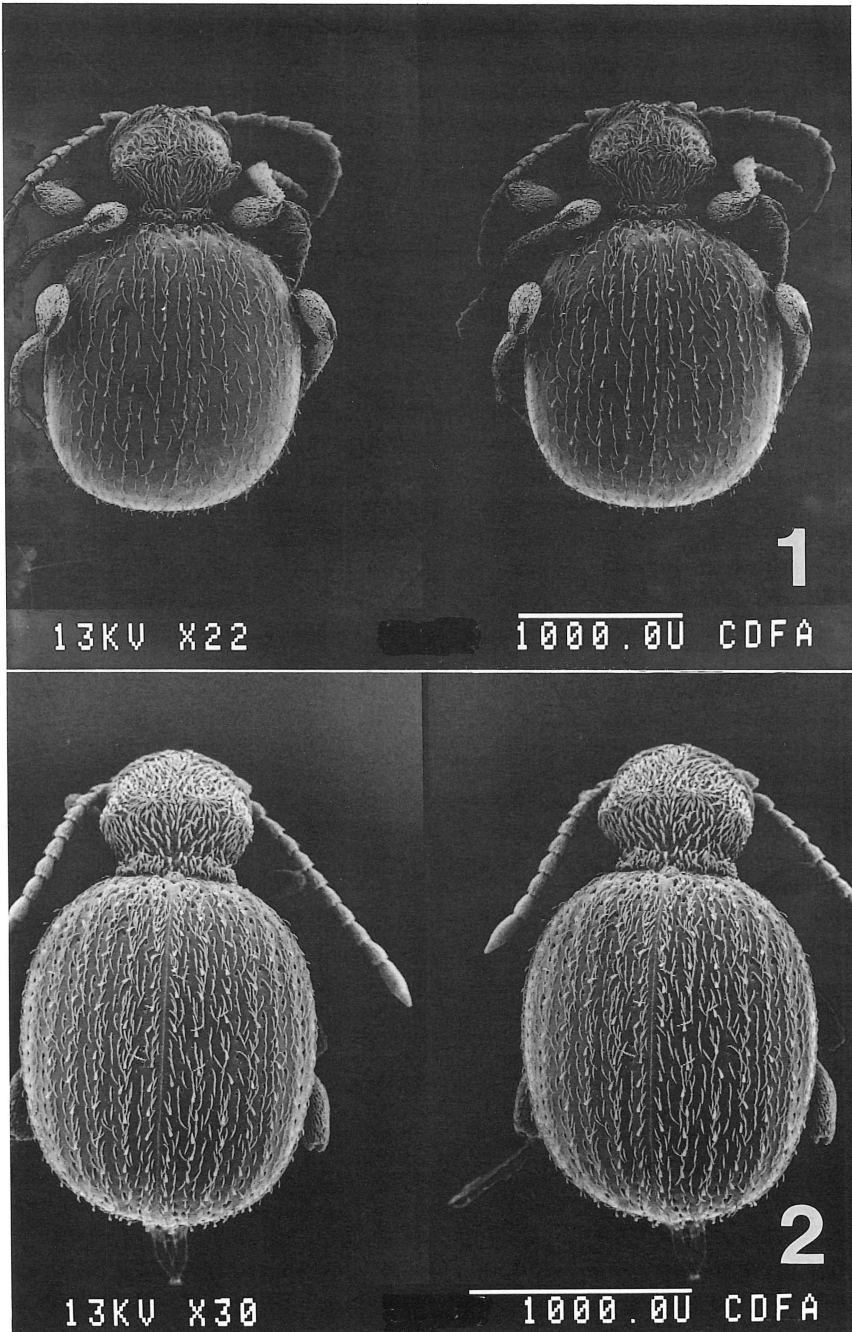
NIPTUS ARCANUS AALBU & ANDREWS, NEW SPECIES
(Figs. 1, 17, 19, 24 and 25)

Types.—HOLOTYPE (female) and ALLOTYPE (male): CALIFORNIA. *SAN BERNARDINO Co.*: Providence Mountains State Recreation Area, Mitchell Caverns, el. 1340 m, El Pakiva Cave, 26 Aug–31 Dec 1978, Ethylene glycol pitfall trap near *Neotoma* nest, #6. Type deposited in California Academy of Sciences Collection. PARATYPES: CALIFORNIA. *SAN BERNARDINO Co.*: Providence Mountains State Recreation Area, Mitchell Caverns, el. 1340 m, El Pakiva Cave, 26 Aug 1978 to 31 Dec 1978 trap #6; 17 Mar 1979 to 16 Jun 1979, trap #3 (4); 17 Mar 1979 to 16 Jun 1979, trap #4 (19); 17 Mar 1979 to 16 Jun 1979, trap #6 (34); 17 Mar 1979 to 16 Jun 1979 (1); 27 May 1978 to 26 Jul 1979, trap #5 (28); 31 Dec 1978 to 17 Mar 1979, trap #5 (1); 31 Dec 1978 to 17 Mar 1979, trap #6 (21); 8 May 1981 to 10 Aug 1981 (11), R. L. Aalbu, Ethylene glycol pitfall trap near *Neotoma* nest. Paratypes deposited in USNM, Cdfa, CISC, CASC, RLAC, OSUC.

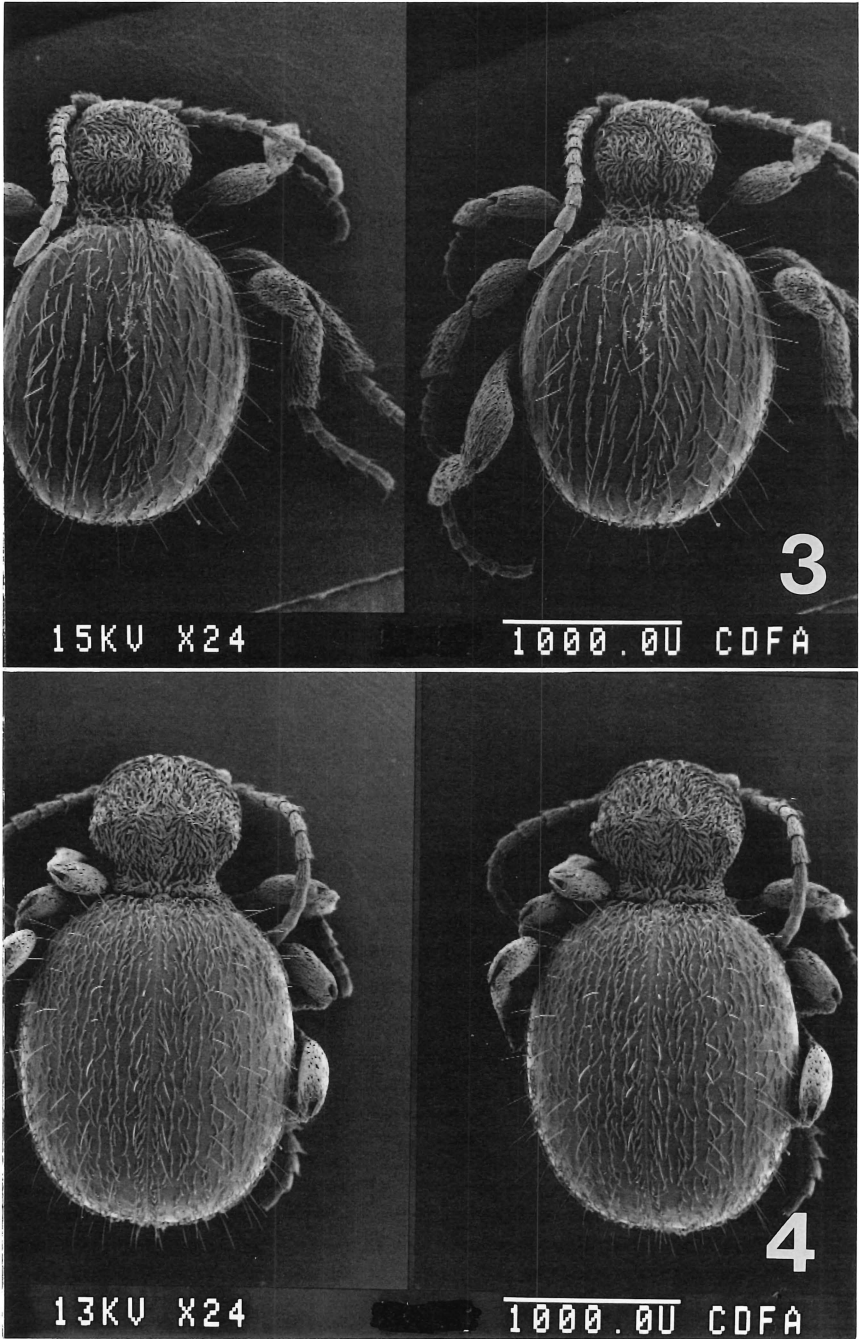
Description.—Female (holotype). Integument red-brown, elytra shiny; length 3.3 mm. HEAD with surface vestiture of closely appressed, spatulate, scale-like setae with few longer fine setae on apical margin of clypeus; antennal fossae with dorsal border not carinate, not laterally elevated; eyes minute, three facets at minimum width, narrowly oval; antenna relatively long, slender, ratio of segment lengths 14:11:10:10:9:9:9:10:10:18. PRONOTUM with surface sculpture of rugose, deep punctures posteriorly forming moderately dense, fine tubercles; surface vestiture of one type, stout, arched, recumbent setae; setae dense at anterior margin, at transverse row of four large tufts; tufts equal in size, positioned near midlength. ELYTRA with surface smooth, shiny, striae punctures fine, nearly obsolete; vestiture of two types, nearly equal in length; first consisting of short moderately slender, erect, spatulate setae positioned in rows at regular distances along first to seventh intervals; second arched, recumbent, moderately slender setae positioned in rows at elytral striae and elytral intervals; setae short, dense at elytral margins. VENTRAL SURFACE: Sterna: ratio of segment lengths 17:19:15:5:19; sternal surface vestiture short, golden, closely appressed, spatulate, scale-like setae intermixed with sparse, slightly longer, less spatulate setae; fifth visible abdominal sternite with medial apical area with closely packed postero-directed, semi-erect setae forming a rounded tubercle-like structure. LEGS slender, femora moderately long, capitate, metafemora bent near apex; tibia slender; femoral vestiture of dense, golden, short, appressed, scale-like setae only varying slightly in length; tibiae with similar vestiture except protibiae with dense, slightly longer, slender, golden setae on lower margins, mesotibiae with dense, slightly longer, slender golden setae on lower margins, on apical one-half of outer margins; metatibiae with few sparse, slightly longer, golden setae on lower margins. Ratios of segment lengths: prothoracic legs, 50:49; mesothoracic legs, 54:52; metathoracic legs, 60:65; protarsi, 10:6:6:6:9; mesotarsi, 12:7:6:6:9; metatarsi, 15:8:7:7:10.

Male (allotype).—Similar to holotype but smaller, approximate length 2.9 mm. Fifth visible abdominal sternite with medial apical area with setae only slightly less appressed, slightly longer than rest of sternal setae; without tubercle-like structure.

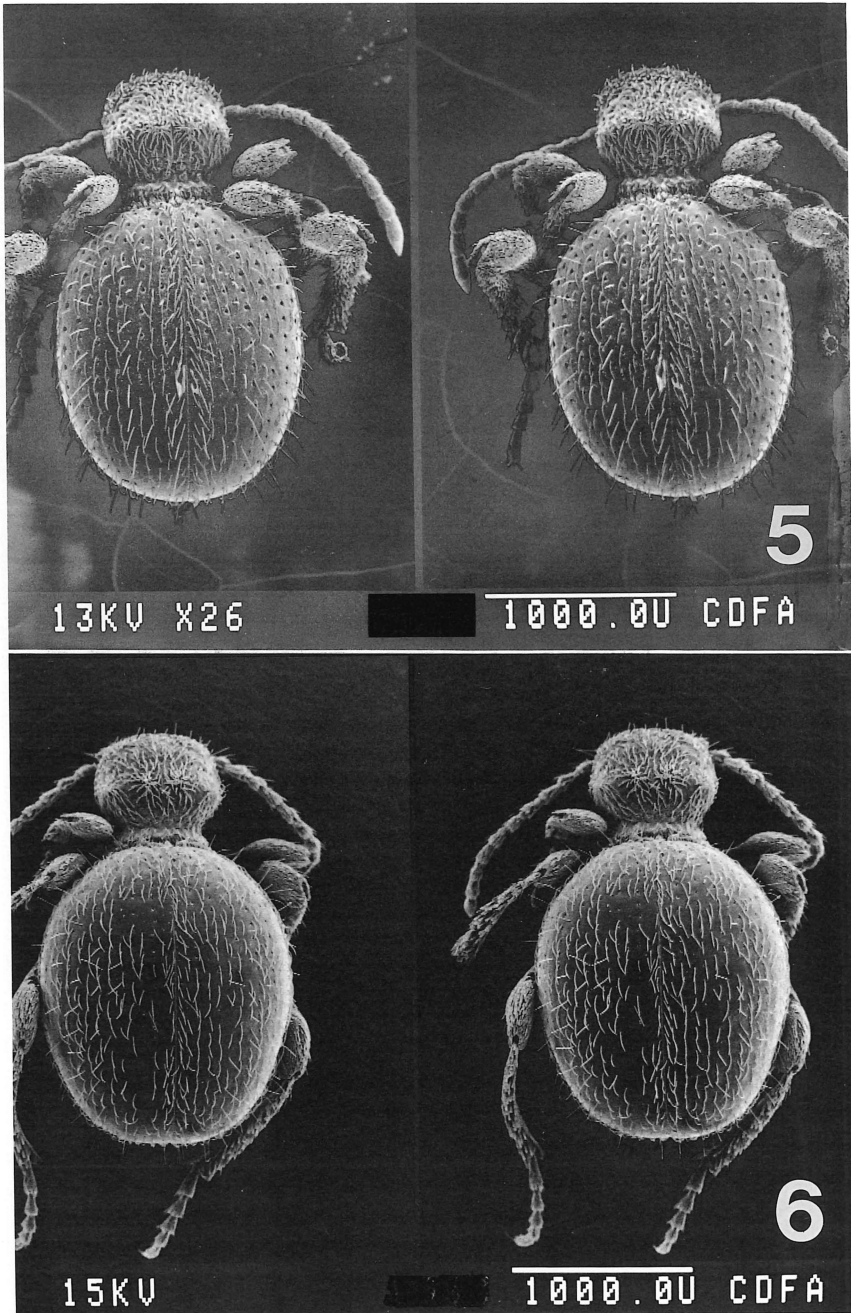
Diagnosis.—The following combination of characters will serve to separate *N. arcanus*: Head with eyes minute (Fig. 24) and antennal fossa with dorsal border



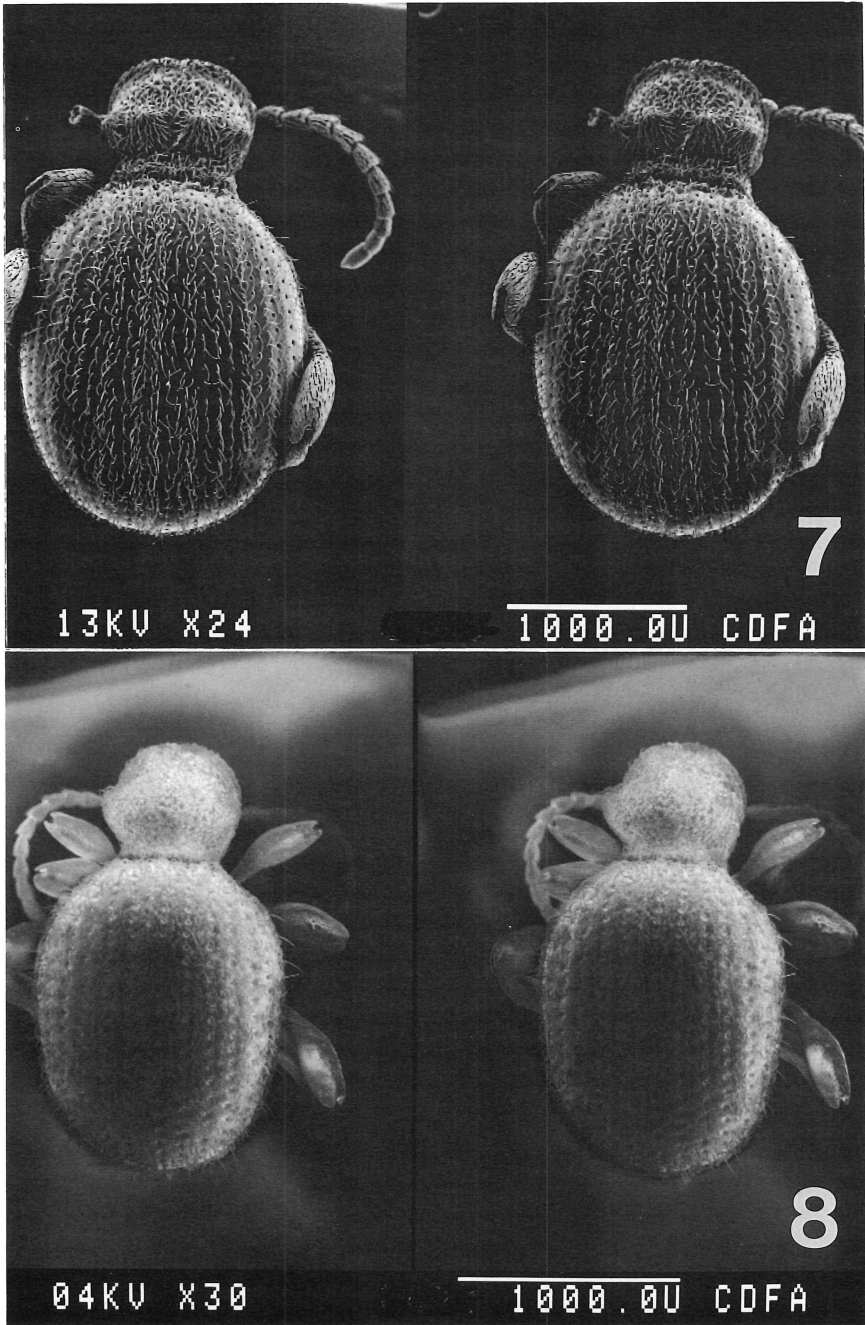
Figures 1–2. Figure 1. *Niptus arcanus*, habitus (stereo pair). Figure 2. *Niptus neotomae*, habitus (stereo pair).



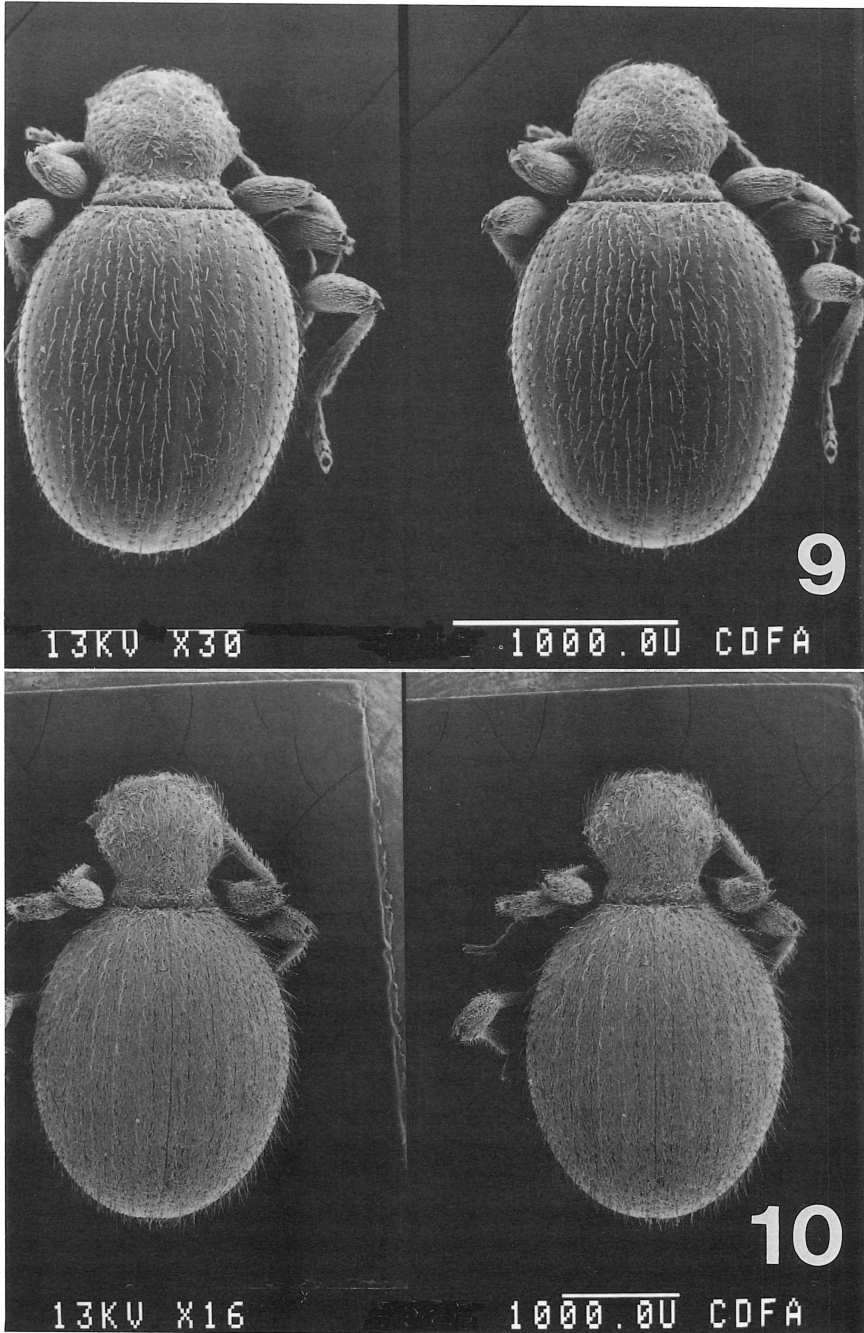
Figures 3-4. Figure 3. *Niptus giulianii*, habitus (stereo pair). Figure 4. *Niptus abditus*, habitus (stereo pair).



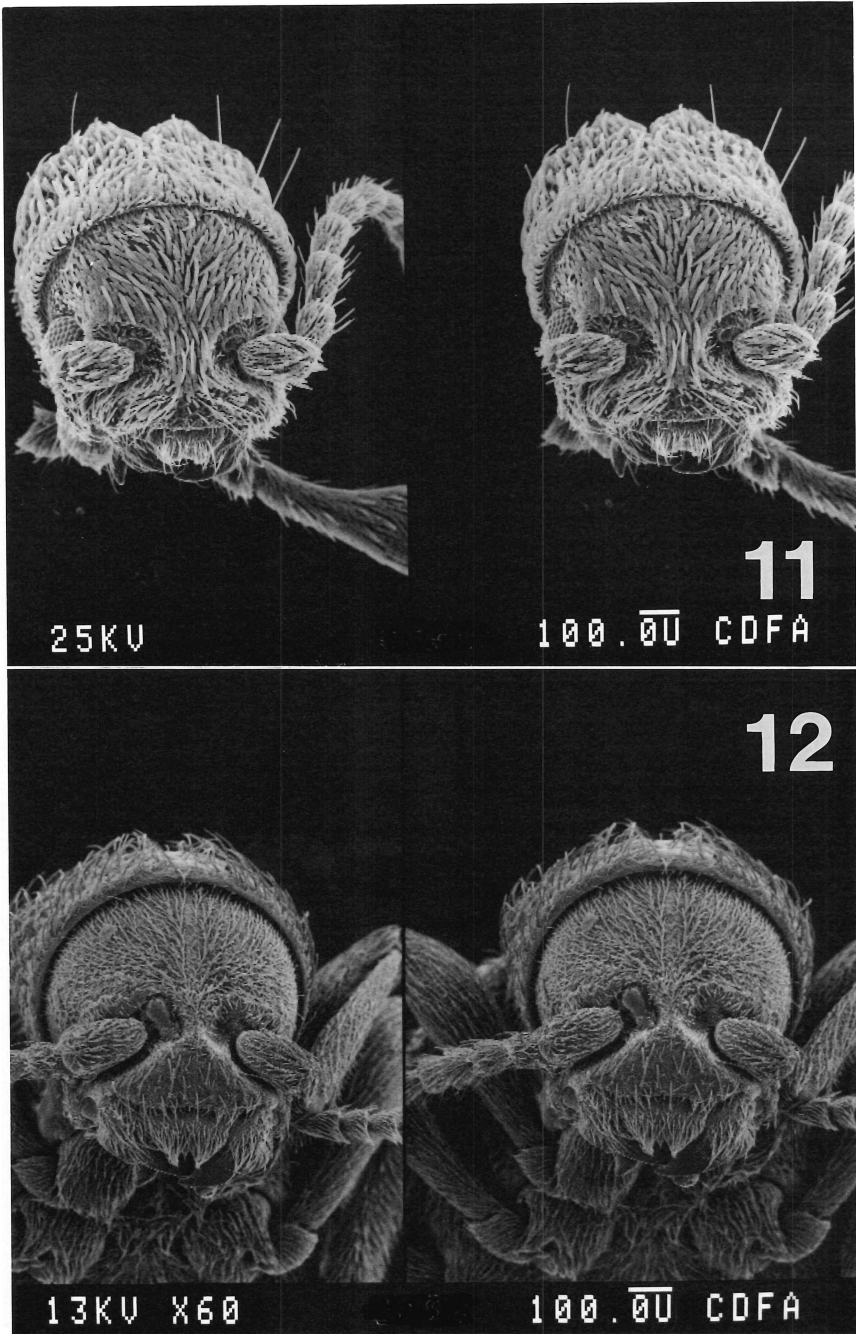
Figures 5–6. Figure 5. *Niptus ventriculus*, habitus (stereo pair). Figure 6. *Niptus abstrusus*, habitus (stereo pair).



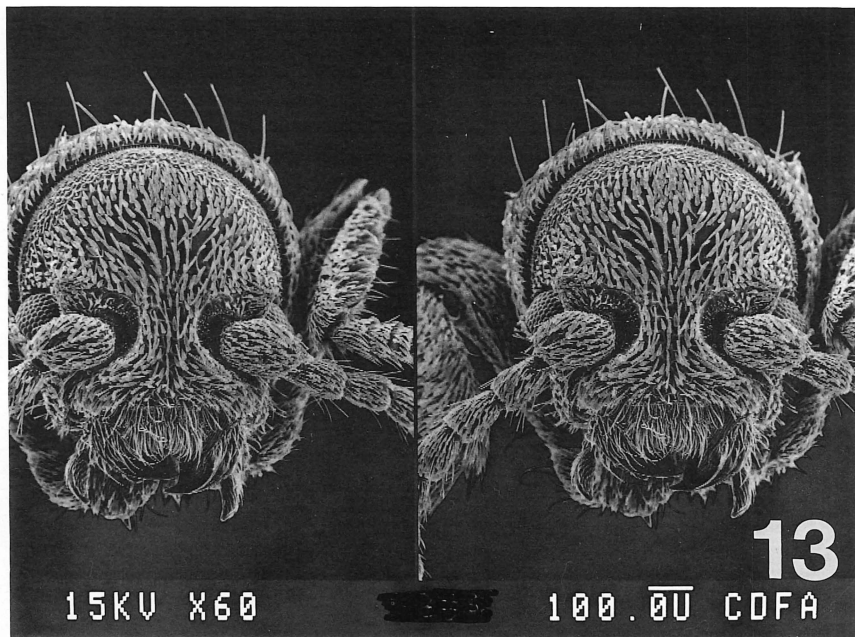
Figures 7-8. Figure 7. *Niptus absconditus*, habitus (stereo pair). Figure 8. *Niptus sleeperi*, habitus (stereo pair).



Figures 9–10. Figure 9. *Niptus hilleri*, habitus (stereo pair). Figure 10. *Niptus hololeucus*, habitus (stereo pair).

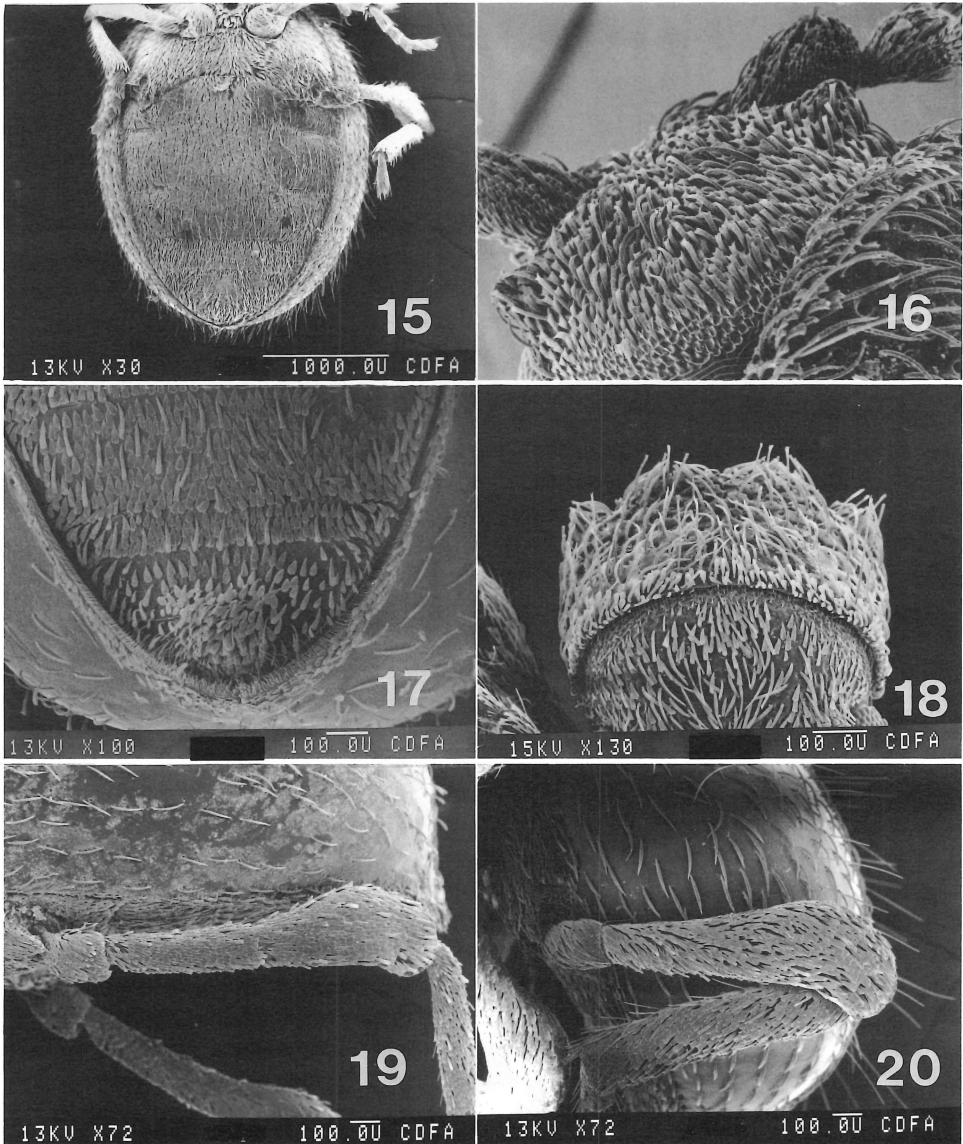


Figures 11–12. Figure 11. *Niptus giulianii*, anterior aspect of head (stereo pair). Figure 12. *Niptus hilleri*, anterior aspect of head (stereo pair).



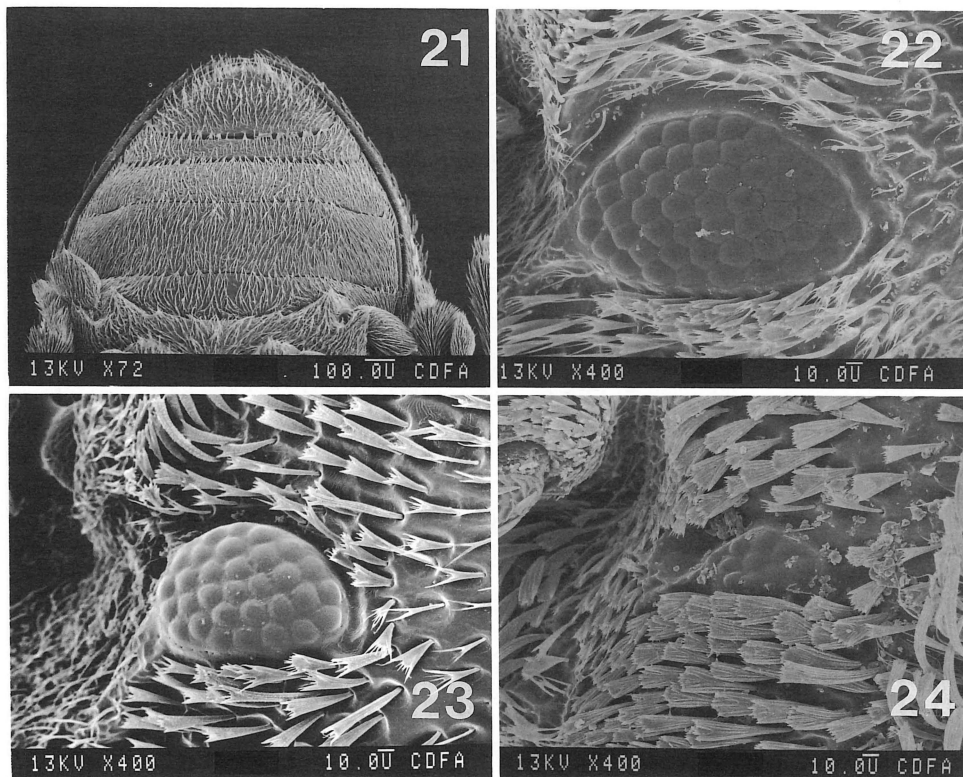
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Figures 13–14. Figure 13. *Niptus ventriculus*, anterior aspect of head (stereo pair). Figure 14. Fecal pellets of *Neotoma lepida* Thomas showing feeding damage by *Niptus arcanus*.



Figures 15–20. Figure 15. *Niptus hololeucus*, sterna, ventral view. Figure 16. *Niptus ventriculus*, dorsal-apical aspect of head. Figure 17. *Niptus arcanus*, apical aspect of sterna, ventral view. Figure 18. *Niptus ventriculus*, dorsal-apical aspect of pronotum. Figure 19. *Niptus arcanus*, lateral aspect of metafemur. Figure 20. *Niptus giulianii*, lateral aspect of metafemur.

not carinate or laterally raised. Pronotum with medial and lateral transverse pronotal tufts equal in size; anterior margin of pronotum without long erect setae. Elytra with erect setae on intervals one to five short, spatulate. Legs long, with metafemur capitate, metatibia slender, slightly curved. Sexually dimorphic: female with fifth visible abdominal sternite with medial apical area bearing closely packed patch of postero-directed, semi-erect setae forming a rounded tubercle-like structure.



Figures 21–24. Figure 21. *Niptus hilleri*, sterna, ventral view. Figure 22. *Niptus ventriculus*, lateral aspect of eye. Figure 23. *Niptus absconditus*, lateral aspect of eye. Figure 24. *Niptus arcanus*, lateral aspect of eye.

Niptus arcanus is most closely related to *N. neotomae*, sharing short spatulate elytral setae. These species also lack long erect setae on pronotal margins as well as being sexually dimorphic, characters also shared by *N. absconditus* Spilman. *Niptus neotomae* differs from *N. arcanus* in having shorter setae both on the pronotum and elytra and in the configuration of the legs. In *N. neotomae*, the legs are short and stout, the metafemora clavate; in *N. arcanus*, the legs are long and slender, the metafemora capitate. *N. arcanus* and *N. absconditus* Spilman also share strongly reduced eyes.

Distribution.—(Fig. 25) This species is only known from the type locality, El Pakiva Cave, Mitchell Caverns, Providence Mountains, San Bernardino County, California.

Label Biological Notations.—Ethylene glycol pitfall trap near *Neotoma* nest, dry pit traps.

Biological Notes.—There are a number of caves in the Providence Mountains State Recreation Area. Mitchell Caverns, located at about 1340 m, actually refers to two separate limestone caves, believed to be Miocene in origin. Both caves are at about the same level, although one cave, El Pakiva, contains a large secondary, lower chamber at the far south end, which is approximately 18 meters lower. These caves were exploited as a tourist attraction in the 1930s. In 1970, to facilitate

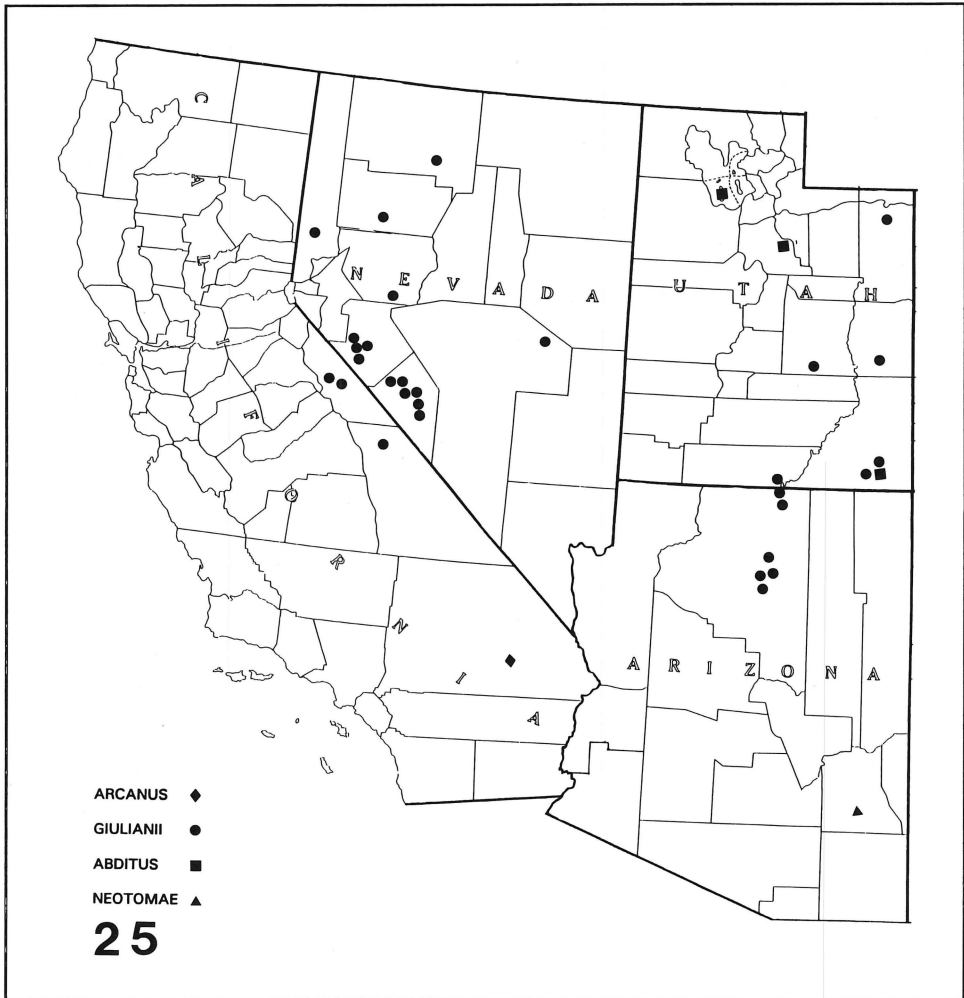


Figure 25. Distribution of *Niptus arcanus* (solid diamond), *Niptus giulianii* (solid circles), *Niptus abditus* (solid squares) and *Niptus neotomae* (solid triangle).

visitor tours, a tunnel was completed connecting the two caves. During the 1979 survey, trapping periods (intended to sample seasonal differences during an entire year) were segregated into four series, averaging approximately three months (see Aalbu 1990).

Although nine years had elapsed since the construction of the tunnel connecting the two caves during the faunal survey, some species of troglomorphic Coleoptera were found to remain concentrated or even completely restricted to one cave. *Niptus arcanus* was the best example. Close to 100% (292) of the specimens were found in both the main section and the lower caverns of El Pakiva (one specimen found near an entrance) but was entirely absent from Tecopa, the other connected cave. This is also one of the few species to be found in numbers deep in the lower caverns of El Pakiva. Specimens of *Niptus* were trapped in greater numbers in the fall but were present in large numbers throughout the year. Since this survey,

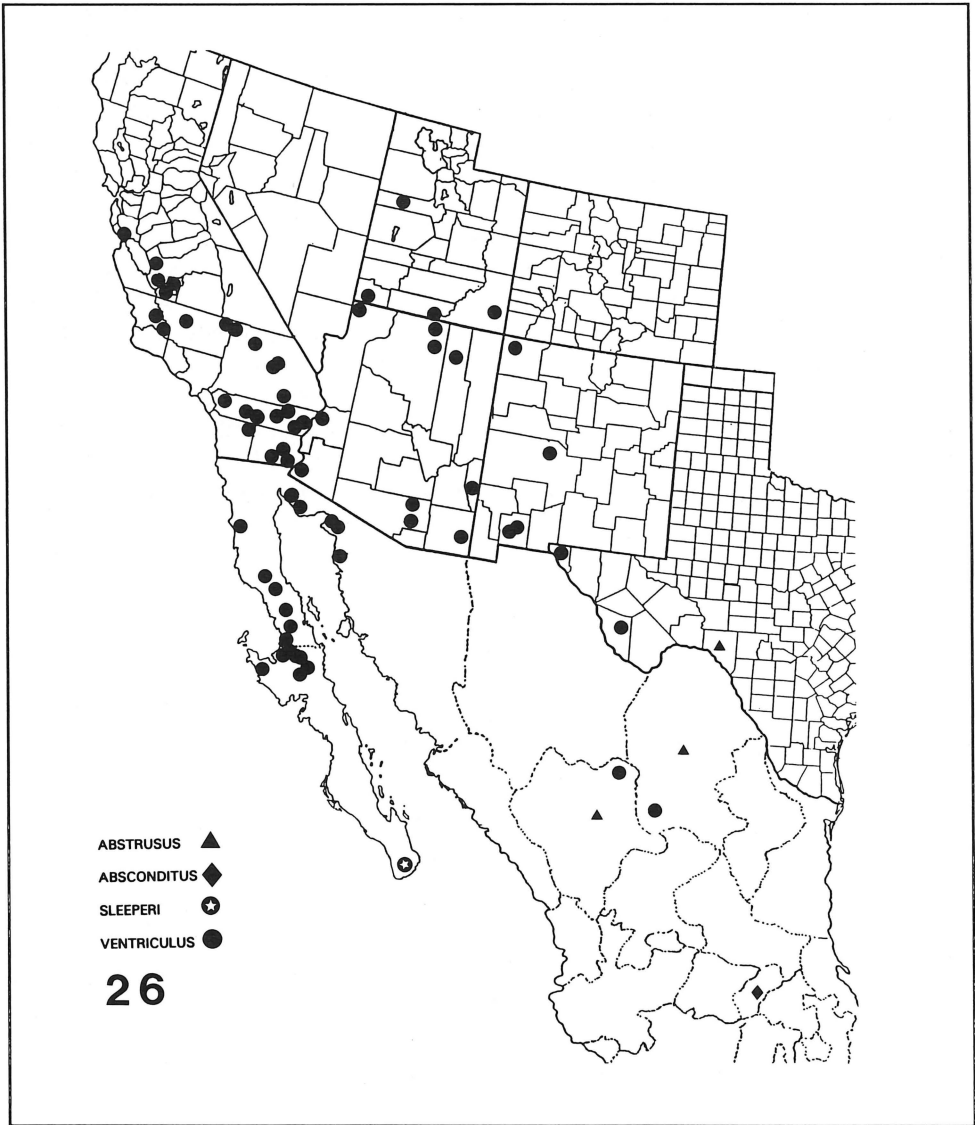


Figure 26. Known geographical distribution of *Niptus abstrusus* (solid triangles), *Niptus absconditus* (solid diamond), *Niptus sleeperi* (star in circle) and *Niptus ventriculus* (solid circles).

other caves (Medicine Cave, Cave of the Winding Stairs) and mines in the area have been surveyed or partially surveyed for insects. *N. arcanus* was not found in any of these.

Most of the food energy in Mitchell Caverns comes in with packrats (*Neotoma lepida* Thomas). The rats bring organic materials, such as twigs, cacti, grass, leaves, etc., collected outside into their nests. The packrats and other rodents, such as mice, also leave fecal pellets, which are found sometimes in great numbers in the caverns. Rodents nesting in the caverns are in most instances not found in the

deeper areas. From data gathered from an analysis of substrate composition near each trap (Aalbu 1990), *Niptus arcanus* was found most abundantly in substrate consisting of mostly fine cave dust, with few calcite and limestone pebbles and rocks, and a small amount of organic matter or in the lower caverns area of very fine, highly organic dust and conglomerate (dust-clay-rocks). *Niptus arcanus* was not abundant in packrat nesting areas. However, it appears there is an association with packrats.

A number of species of ptinids are known to breed in rat dung (Howe 1959), but no larvae were trapped or found in the cave substrate. Close examination of *Neotoma* droppings in the areas of *Niptus* abundance proved interesting. Most of these droppings, although relatively few in numbers compared with packrat nesting areas in other parts of the cave, contained numerous cavities with diameters approximately equal to *Niptus* specimens in size. No other insect in the area is known to create similar cavities. It appears that the larvae, and possibly also the adults, of this species feed on *Neotoma* pellets (Fig. 14). Unfortunately, attempts to rear live adults on the dung were unsuccessful as adults died within a short period of time.

An additional ptinid, *Ptinus feminalis* Fall, was also trapped in the caves. This species has a wide geographical range. It is known to feed on dried vegetable matter and animal substances. *P. feminalis* was found in both caves during the survey. Most were found near the entrances.

Material Examined.—313 specimens (see types), from the type locality distributed as follows: 292 trapped during cave survey (see Aalbu 1990: table 6); 12 from substrate samples and nine collected alive in pitfall traps 6 Jun–20 Jun 1988.

NIPTUS GIULIANII AALBU & ANDREWS, NEW SPECIES
(Figs. 3, 11, 20 and 25)

Types.—HOLOTYPE (female): ARIZONA. COCONINO Co.: 6.3 km SE of Moenkopi, sand dunes/ dry canyon, 31 Jul–1 Aug 1983, Rolf L. Aalbu coll., dry overnight “punch cup” pitfall trap. ALLOTYPE (male): UTAH. UINTAH Co.: 16.1 km SSW of Vernal, 28–29 Jul 1983, Rolf L. Aalbu coll., dry overnight “punch cup” pitfall trap. Holotype and allotype deposited in the collection of the California Academy of Sciences. PARATYPES: ARIZONA. COCONINO Co.: 3.2 km S of Moenkopi, 3 Jul 1972, F. Andrews & E. A. Kane [CDFA] (49); 1.6 km E of Moenkopi, 31 Jul 1983 to 1 Aug 1983, R. L. Aalbu pitfall near *Neotoma* nest, [RLAC] (9); 6.3 km SE of Moenkopi, sand dunes/dry canyon, 31 Jul 1983 to 1 Aug 1983, R. L. Aalbu, pit traps [RLAC] (161); 3.9 km S of Moenkopi, Moenkopi Dunes, 17 Jul 1975, F. Andrews & A. Hardy, cereal bowl trap [CDFA] (11); Moenkopi sand dunes, Mar 1983 to Sep 1983, D. Giuliani, antifreeze pit trap [CDFA] (21); Waheap, 4.8 km NW of Lake Powell, 1 to 2 Aug 1983, R. L. Aalbu [RLAC] (10); 19.3 km ENE of Tuba City, 31 Jul 1983 to 1 Aug 1983, R. L. Aalbu, sand dunes/dry canyon, [RLAC] (25). CALIFORNIA. INYO Co.: Deep Springs Valley Sand Dunes, 17 July 1975, [CDFA] (1); 17 Jun 1978 to 28 Sep 1978, [CDFA] (1); 28 Sep 1979 to 15 Dec 1979, [CDFA] (1); 13 May 1980 to 29 Sep 1980; Deep Springs Valley Sand Dunes, (5000 ft), D. Giuliani, antifreeze pit trap, [CDFA] (2). MONO Co.: Mono Lake, sand dunes, 17 Aug 1979 to 21 Nov 1979 [CDFA] (6); same locality, 21 Nov 1979 to 7 Jun 1980 [CDFA] (2); same locality,

7 Jun 1980 to 1 Sep 1980 [CDFA] (17), D. Giuliani, antifreeze pit trap; Mono Lake, NE end, sand dunes, 15 Jun 1979 to 17 Aug 1979, D. Giuliani, antifreeze pit trap, [CDFA] (56); Mono Lake, 1 km E of Sulfur Pond, #17, no date, J. H. Harris, ethylene glycol pit trap [CDFA] (4). *SANTA CRUZ Co.*: Watsonville, May 1936, E. L. Kellogg [CDFA] (1). *NEVADA. CHURCHILL Co.*: Sand Mountain, 19 Jul 1977, D. Giuliani, UV light [CDFA] (1); Sand Mountain dunes, 16 Sep 1974, F. Andrews & A. Hardy [CDFA] (18). *ESMERALDA Co.*: Clayton Valley Sand Dunes, 17 Sep 1974, F. Andrews & A. Hardy [CDFA] (3); Clayton Valley Sand Dunes, 11.3 km S of Silver Peak, 1280 m, 2 May 1974, T. Eichlin & A. Hardy [CDFA] (3); 9.7 km N of Oasis, 3.2 km W of Fish Lake Valley, 1376 m, 24 Feb 1982 to 24 Jun 1982, D. Giuliani, antifreeze pit trap, [CDFA] (3); Fish Lake Valley Sand Dunes, 17 Aug 1976, D. Giuliani, cereal bowl pit trap [CDFA] (1); 11.3 km N of Dyer, sand dunes, 1494 m, 24 Jun 1982 to 30 Sep 1982, D. Giuliani, antifreeze pit trap [CDFA] (2); 16.1 km SE of Dyer, sand dunes, 1494 m, 24 June 1982 to 30 Sep 1982, D. Giuliani, antifreeze pit trap [CDFA] (4); 21 km N, 12.9 km E of Dyer, Fish Lake Valley, 1433 m, Sep 1986 to Sep 1987, D. Giuliani, antifreeze pit trap [CDFA] (11); 4.8 km N of Goldfield, sand dunes, 1676 m, 28 Mar 1982 to 1 Oct 1982, [CDFA] (6); same locality, Mar 1983 to Sep 1983, [CDFA] (4); same locality, Oct 1982 to Mar 1983, D. Giuliani, antifreeze pit trap [CDFA] (1). *HUMBOLDT CO.*: 19.3 km NW of Winnemucca, 18 Jul 1977, D. Giuliani, cereal bowl trap [CDFA] (23). *MINERAL Co.*: Teels Marsh, 17 Feb 1979 to 16 Jul 1979, D. Giuliani, antifreeze pit trap, sand dune association [CDFA] (6); Teels Marsh, sand dunes, 22 May 1976 [CDFA] (25); same locality, 16 Aug 1979 to 22 Nov 1979, [CDFA] (13); 22 Sep 1979 to 30 Jan 1980, [CDFA] (7); 7 Jun 1980 to 31 Aug 1980, D. Giuliani, antifreeze pit trap, [CDFA] (11); 8 km W of Marietta, sand dunes, 1920 m, 6 Jun 1980, D. Giuliani [CDFA] (1); 12.9 km S of Mina, sand dunes, 22 May 1976, D. Giuliani [CDFA] (14); 14.5 km S of Mina, 30 Jun 1965, M. E. Irwin, sand dune association [CDFA] (2); Huntoon Valley Sand Dunes, 16 Aug 1979 to 22 Sep 1979 [CDFA] (3); same locality, 7 Jun 1980 to 31 Aug 1980 [CDFA] (4); same locality, 31 Aug 1980 to 25 May 1981 [CDFA] (1); D. Giuliani, antifreeze pit trap. *NYE Co.*: Current, 14.5 km S, 3.2 km W of Railroad Valley, 1494 m, Sep 1986 to Sep 1987, D. Giuliani, antifreeze pit trap [CDFA] (3). *PERSHING Co.*: Woolsey, 27 Jun 1972, T. R. Haig [CDFA] (1); Woolsey RR Stn., 6 June 1973, T. R. Haig, blacklight [CDFA] (1). *WASHOE Co.*: Pyramid Lake Dunes, 7 Sep 1941, LaRivers [CASC] (3). *UTAH. EMERY Co.*: 27.4 km N of Hanksville, sand dunes nr. Glison Butte Well, 26 Jul 1978, F. Andrews & A. Hardy, cereal bowl trap [CDFA] (22); 20.8 km N, 11.2 km E of Hanksville, sand dunes, Sep 1983 to Mar 1984, D. Giuliani, antifreeze pit trap [CDFA] (9). *GRAND Co.*: Arches Nat. Mon., Devils Garden Campgr., 14 Sep 1983, R. L. Aalbu [RLAC] (19). *KANE Co.*: 8 km SE of Glen Canyon City, sand dunes, 15–17 Jun 1988, R. L. Aalbu, pit traps, sand dune/rodent burrows, [RLAC] (4); Lake Powell, Lone Rock Campgr., 15/17 Jun 1988, R. L. Aalbu, pit traps, sand dune/rodent burrows, [RLAC] (44); Kanab, 16.1 km N of Kanab cyn., 18–19 Jun 1988, R. L. Aalbu, pit trap sandstone overhang *Neotoma* nest, [RLAC] (3). *SAN JUAN Co.*: Bluff Sand Dunes, 8 km W of Bluff, 24 Jul 1978, F. Andrews & A. Hardy, cereal bowl trap [CDFA] (13). *UINTAH Co.*: 16.1 km SSW of Vernal, 13 Sep 1983, R. L. Aalbu [RLAC] (14). Paratypes deposited in USNM, CASC, CISC, CASC, RLAC, OSUC.

Description.—Female (holotype). Integument red-brown, elytra shiny; length approximately 2.9 mm. HEAD with surface vestiture consisting of closely appressed, spatulate, scale-like setae with few longer fine setae on apical margin of clypeus; antennal fossae with dorsal border not carinate, not laterally elevated; eyes large, at least seven facets wide at minimum width, oval; antenna of moderate length, stout, ratio of segment lengths 11:9:8:8:8:8:8:8:9:15. PRONOTUM with surface sculpture consisting of rugose, deep punctures posteriorly forming moderately dense, small tubercles; surface vestiture of two types, first of sparse, long setae in a row at anterior margin; second of short, stout, arched, recumbent setae, dense, often subspatulate, forming dense ring at anterior margin; midlength transverse row of four tufts unequal in size, medial tufts prominent, lateral tufts small to nearly obsolete. ELYTRA with surface smooth, shiny, striae punctures obsolete; vestiture of two types: first of long, fine, erect setae sparsely positioned at regular intervals on first, third, fifth, seventh intervals; second of moderately long, stout, arched, recumbent setae, positioned in rows on elytral intervals, more abundant and shorter, around suture, on lateral margins. VENTRAL SURFACE: Sterna: ratio of segment lengths 15:17:15:5:19; sternal surface vestiture of short, dense golden closely appressed, spatulate setae intermixed with less dense, slightly longer, fine setae; fifth visible abdominal sternite with medial apical area with closely packed patch of short appressed, scale-like setae. LEGS stout, with femora short, clavate; tibiae short; metatibia curved proximal-posteriorly; femoral vestiture consisting of dense, golden, short, appressed, scale-like setae only slightly varying in length; tibiae with similar vestiture except protibiae with dense, longer, slender, golden setae on lower margins; mesotibiae with dense, longer, slender, golden setae on lower margins, on apical one-half of outer margins; metatibiae with few sparse, longer, golden setae on lower margins. Ratios of segment lengths: prothoracic legs, 41:40; mesothoracic legs, 46:45; metathoracic legs, 60:59; protarsi, 8:4:4:4:7; mesotarsi, 10:4:4:4:9; metatarsi, 15:7:6:6:11.

Male (allotype).—Similar to holotype but smaller, approximate length 2.6 mm. Fifth visible abdominal sternite with medial apical area with setae similar to rest of sternal area.

Diagnosis.—The following combination of characters will serve to separate *N. giulianii*: Head with eyes large and antennal fossa with dorsal border not carinate or laterally raised. Pronotum with medial transverse pronotal tufts, larger than lateral tufts; anterior margin of pronotum with long erect setae. Elytra with erect setae on intervals three and five long and slender, short on one and absent on two and four. Legs short, with metafemur clavate, metatibia stout, curved proximal-posteriorly. Sexually dimorphic: female with fifth visible abdominal sternite with medial apical area bearing closely packed patch of minute, scale-like setae.

Label Biological Notations.—Dry overnight “punch cup” pitfall trap, ethylene glycol pitfall trap near *Neotoma* nest, pit traps sand dune/rodent burrows, pit traps sandstone overhang *Neotoma* nest.

Distribution.—(Fig. 25) The peculiar east-west distribution of this species probably reflects lack of adequate collections from this middle area instead of a real distributional gap. There is, however, a curious absence of this species from the Eureka Valley sand dunes region, an area that has undergone intensive trapping; whereas, the species is present in Deep Springs Valley sand dunes, only eight miles away.

Biological Notes.—This species is often associated with rodent burrows near or on sand dunes, although it is also found off of the dunes.

Material examined.—See types.

NIPTUS NEOTOMAE AALBU & ANDREWS, NEW SPECIES
(Figs. 2 and 25)

Types.—HOLOTYPE (female) and ALLOTYPE (male): ARIZONA. GRAHAM Co.: Pinaleno Mountains, Heliograph Peak, 3055 m elevation, 9 Sep 1987, G. E. Haas col. Holotype and allotype deposited in the collection of the California

Academy of Sciences. PARATYPES: 5, same data. Deposited in USNM, CDFA and RLAC.

Description.—Female (holotype). Integument red-brown, elytra shiny; length approximately 2.6 mm. HEAD with surface vestiture consisting of closely appressed, short, spatulate, scale-like setae; antennal fossae with dorsal border not carinate, not laterally elevated; eyes small, five facets at minimum width, oval in shape; antenna of moderate length, ratio of segment lengths 10:8:7:6:6:6:6:7:13. PRO- NOTUM with surface sculpture consisting of rugose punctures; surface vestiture of short, stout, recumbent setae; setae dense at anterior margin, at transverse row of four weakly developed tufts; tufts equal in size, positioned near midlength. ELYTRA with surface shiny, sculpture small deep regular punctures; vestiture of two types, nearly equal in length; first of short, moderately slender, erect, strongly spatulate setae positioned in rows at regular distances along first to seventh intervals; second arched, recumbent, moderately slender setae positioned in approximate rows on both elytral striae and elytral intervals; setae short, dense at elytral margins. VENTRAL SURFACE: Sterna: ratio of segment lengths 12:15:14:4:17; sternal surface vestiture consisting of short, closely appressed, spatulate, scale-like setae; fifth visible abdominal sternite with medial apical area with dense patch of apically directed, semi-erect setae. LEGS stout, femora short, clavate, metafemora slightly bent near apex; tibia stout; femoral vestiture consisting of dense, golden, short, appressed, scale-like setae only slightly varying in length; tibiae with similar vestiture except protibiae with dense, slightly longer, slender, golden setae on lower margins, mesotibiae with dense, slightly longer, slender, golden setae on lower margins, on apical one-half of outer margins; metatibiae with few sparse, slightly longer, golden setae on lower margins. Ratio of segment lengths: prothoracic legs, 32:31; mesothoracic legs, 35:33; metathoracic legs, 39:40; protarsi, 5:4:3:4:7; mesotarsi, 5:4:4:4:6; metatarsi, 8:5:4:4:7.

Male (allotype).—Similar to holotype but slightly smaller, approximate length 2.3 mm; eyes slightly smaller than female, four facets in width; fifth visible abdominal sternite with setal pattern unmodified.

Diagnosis.—The following combination of characters will serve to separate *N. neotomae*: Head with eyes small and antennal fossa with dorsal border not carinate or laterally raised. Pronotum with medial, lateral transverse pronotal tufts equal in size, only slightly developed; anterior margin of pronotum without long erect setae. Elytra with erect setae on intervals one to five short, spatulate. Legs short, stout, with metafemur clavate. Sexually dimorphic: female with fifth visible abdominal sternite with medial apical area bearing closely packed apically directed, semi-erect setae forming a rounded patch.

Niptus neotomae is most closely related to *N. arcanus*, sharing short spatulate elytral setae. These species also lack long erect setae on pronotal margins and have sexual dimorphism, characters also shared by *N. absconditus* Spilman. *Niptus neotomae* differs from *N. arcanus* in having shorter setae both on the pronotum and elytra and in the configuration of the legs: short and stout, metafemora clavate in *N. neotomae*; long and slender, metafemora capitate in *N. arcanus*.

Distribution.—(Fig. 25) This species is only known from the type locality.

Label Biological Notations.—Nest of *Neotoma mexicana* in U.S.F.S. shed.

Biological Notes.—Haas (T. J. Spilman, personal communication) mentions finding the beetles while searching for fleas in a rather dry and dusty nest composed of shredded cloth, newspapers, wrappers, cardboard, and packing material surrounded by cones, bark, sticks and various dried green plant material on the floor of the shed between some storage boxes.

Material Examined.—See types.

NIPTUS ABSTRUSUS SPILMAN
(Figs. 6 and 26)

Niptus abstrusus Spilman, 1968: 195.

Diagnosis.—The following combination of characters will serve to separate *N. abstrusus*: Head with eyes small and antennal fossa with dorsal border carinate and laterally raised. Pronotum with medial and lateral transverse pronotal tufts equal in length; anterior margin of pronotum with long erect setae. Elytra with erect setae on intervals three and five only slightly longer than those on intervals one, two and four; legs with metafemur clavate, metatibia stout, curved. Not sexually dimorphic.

Distribution.—(Fig. 26) Southwestern Texas and north-central Mexico. Known from caves in Texas (Fern Cave [Val Verde Co.], Bat Cave [Brewster Co.]) and Mexico (Pedrigosa Circle Cave, Pedrigosa Pipe Cave, and Cueva de San Vicente [Coahuila]).

Label Biological Notations.—On pineapple, on dry beans, with *Ariocarpus lloydi*.

Biological Notes.—Ashworth (1973) reports finding fragments of individuals of this species in a 12,000 year old fossil *Neotoma* nest in western Texas. Individuals have been reported on raccoon droppings (Reddell 1966) and on bat guano (Reddell 1970).

Material Examined.—Twenty-one from the following seven localities: TEXAS. VAL VERDE Co.: Fern Cave, 27.4 km N of Comstock (7); bat room (3). MEXICO. (2) (state unknown) DURANGO: Tepehuanes (8). COAHUILA: (1).

NIPTUS ABSCONDITUS SPILMAN

(Figs. 7, 23 and 26)

Niptus absconditus Spilman, 1968: 197.

Diagnosis.—The following combination of characters will serve to separate *N. absconditus*: Head with eyes small and antennal fossa with dorsal border not carinate or laterally raised. Pronotum with medial and lateral transverse pronotal tufts equal in size; anterior margin of pronotum without long erect setae. Elytra with erect setae on intervals one to five short; legs long, with metafemur capitate, metatibia stout, almost straight. Sexually dimorphic: female with fifth visible abdominal sternite with medial apical area bearing closely packed patch of dense, short scale-like setae. *Niptus absconditus* is most closely related to *N. arcanus*. See discussion under *N. arcanus*.

Distribution.—This species is only known from the type locality.

Label Biological Notations.—None.

Material Examined.—Four specimens (PARATYPES) from: MEXICO. HIDALGO: Grutas de Xoxafi, VIII-19-65, J. Reddell, J. Fish & W. Bell cols.

NIPTUS ABDITUS BROWN

(Figs. 4 and 25)

Niptus abditus Brown, 1959: 631.

Diagnosis.—The following combination of characters will serve to separate *N. abditus*: Head with eyes minute and antennal fossa with dorsal border not carinate or laterally raised. Pronotum with lateral transverse pronotal tufts more developed than medial pronotal setal tufts; anterior margin of pronotum without long erect setae. Elytra with erect setae on intervals three and five longer than those on intervals one, two and four; legs with metafemur capitate, metatibia slender,

straight. Sexually dimorphic: female with fifth visible abdominal sternite with medial apical area bearing closely packed patch of postero-directed, semi-erect setae forming a rounded tuberclelike structure.

Distribution.—This species is only known from the three localities mentioned.

Label Biological Notations.—Ex. nest of *Neotoma* sp., ethylene glycol pit trap.

Material Examined.—UTAH. *SAN JUAN Co.*: 12.9 km E of Bluff, 1402 m, September 1984 to March 1985, ethylene glycol pit trap, D. Giuliani col. (2). *TOOELE Co.*: Great Salt Lake, Stansbury Island, floor of Spider Cave, 9.1 m from the entrance, 29 Nov 1952, J. R. Keller col., PARATYPE #6916, [CNCI]. *UTAH Co.*: Rock Canyon near Provo, 15 Jun 1964, V. J. Tipton col., (8).

NIPTUS SLEEPERI AALBU & ANDREWS, NEW SPECIES

(Figs. 8 and 16)

Type.—Holotype (male). MEXICO. *BAJA CALIFORNIA SUR*: 27.4 air km ENE of Todos Santos, Sierra Laguna, La Laguna, 4–7 Jun 1973, E. L. Sleeper col. Type deposited in California Academy of Sciences Collection.

Description.—Male (holotype). Integument dark red-brown, vestiture golden to yellow; length approximately 2.4 mm. HEAD with surface vestiture consisting of closely appressed, spatulate, scale-like setae with few longer fine setae on apical margin of clypeus; antennal fossae with dorsal border carinate, laterally elevated; eyes small, four facets at minimum width, narrowly oval in shape; antenna short, stout; ratio of segment lengths 10:9:7:6:6:6:6:7:13. PRONOTUM with surface sculpture consisting of rugose, deep punctures posteriorly forming moderately dense, small tubercles; surface vestiture of two types, first of few, sparse, moderately long, fine setae (with apical ends occasionally finely spatulate) positioned near anterior margin; second of short, stout, dense, arched, recumbent setae; setae denser, shorter, stouter at anterior margin; denser at midlength transverse row of four tufts; tufts equal in size. ELYTRA with surface sculpture of deeply impressed, large, contiguous striae punctures, equal in size, impression throughout; surface vestiture of two types: first of moderately long, fine, sparse, erect setae (equal in length to erect setae on pronotal margin) positioned at regular intervals along first to seventh elytral intervals; second of shorter, stout, arched, recumbent setae positioned throughout elytral surface, more abundant on intervals. VENTRAL SURFACE: Sterna: ratio of segment lengths 11:12:6:3:15; sternal surface vestiture of short, golden, closely appressed, fine setae; fifth visible abdominal sternite with medial apical area unmodified. LEGS short, stout, with femora clavate; tibiae short; metatibia curved proximoposteriorly; femoral vestiture consisting of dense, golden, short, appressed, scale-like setae slightly varying in length; tibiae with similar vestiture except: protibiae with dense, longer, slender, golden setae on lower margins, mesotibiae with dense, longer, slender golden setae on lower margins, on apical one-half of outer margins; metatibiae with few sparse, longer, golden setae on lower margins. Ratio of segment lengths: prothoracic legs, 28:31; mesothoracic legs, 40:33; metathoracic legs, 37:42; protarsi, 5:3:3:3:6; mesotarsi, 7:3:3:3:7; metatarsi, 9:4:4:4:7.

Female.—Unknown.

Diagnosis.—The following combination of characters will separate *N. sleeperi*: Head with eyes small and antennal fossa with dorsal border carinate, laterally raised. Pronotum with medial and lateral transverse pronotal tufts equally developed; anterior margin of pronotum with long erect setae. Elytra with deeply impressed, large, contiguous striae punctures, equal in size and impression throughout; erect setae on intervals one to five short. Legs with metafemur clavate, stout, metatibia stout, curved. Sexual dimorphism unknown.

Distribution.—(Fig. 26) This species is only known from the type locality.

Label Biological Notations.—Berlesed from oak duff.

Material Examined.—Holotype; only it is known.

NIPTUS VENTRICULUS LeCONTE
(Figs. 5, 13, 16, 18, 22, and 26)

Niptus ventriculus LeConte, 1859: 13.

Diagnosis.—The following combination of characters will separate *N. ventriculus*: Head with eyes large and antennal fossa with dorsal border carinate, laterally raised. Pronotum with medial and lateral transverse pronotal tufts equally developed; anterior margin of pronotum with long erect setae. Elytra with erect setae on intervals three and five long; short on intervals one, two and four. Legs with metafemur clavate, metatibia broad, curved. Not sexually dimorphic.

Elytral striae setal length and punctures vary greatly in populations from subequal setal length and completely smooth punctures, except for the ninth interval in specimens from Coahuila, to slight variation in striae setal length and few rows of punctures in specimens from Glamis, California, to strongly punctate with long setae in specimens from near Bakersfield, California.

Label Biological Notations.—UV light; rodent nest; ex mouse nest *Peromyscus eremicus*; kangaroo rats: in burrows of, excavating and sifting burrow of; sifting beach dunes under ambrosia; base of Palo Verde; at night: walking dunes, pitfall; pitfalls: cereal bowl trap, under *Larrea* and *Petelonyx thurberi*, ethylene glycol trap, antifreeze trap on sand dune with creosote and sand verbenas, rye bread trap, dry overnight "punch cup" trap, interdune traps. Spilman (1968) mentions records from nests of *Neotoma*, and the kangaroo rats *Dipodomys deserti* Stephens and *Dipodomys spectabilis* Merriam, pitfall traps in sand dunes, under seaweed and rocks at high tide line, sifting sand on dunes, pit traps sand dune/rodent burrows, antifreeze pit trap on sand dune.

Distribution.—(Fig. 26) Widespread throughout southwest U.S. and Mexico.

Material Examined.—(945 from the following 103 localities). ARIZONA (76 specimens/12 localities). no locality (3). COCHISE Co.: 6.4 km E of Portal (1); A.M.S.W.R.S. (7). COCONINO Co.: Moenkopi, Moenkopi sand dunes (12); 6.3 km SE of Moenkopi, sand dunes/dry canyon (11); 3.2 km S of Moenkopi (3); 16.1 km S and 8 km W of Page (29). GREENLEE Co.: Guthrie (3). LA PAZ Co.: 4.8 km SE of Parker (1). MOHAVE Co.: Littlefield, 580 m (7). NAVAJO Co.: (1). PIMA Co.: Santa Rita Mts. (5). YUMA Co.: Yuma (4); CALIFORNIA (302 specimens/50 localities). FRESNO Co.: Monocline Ridge Sand Dunes (1); 12.9 km NNW of Coalinga, Los Gatos Cyn. (2); 29 km SW of Mendota, Cievo Hills (5). IMPERIAL Co.: Holtville (1); 12.9 km ESE of Holtville, East Mesa Geothermal Site (11); Seely (17); Glamis (31); 1.6 km S of Glamis (6); 4.8 km NW of Glamis (1); 22.5 km NW of Glamis (5); 1.6 km N of Glamis (25); 3.2 km N of Glamis (1); 3.2 km NW of Glamis (13); 5.6 km WNW of Glamis (2); 5.6 km NW of Glamis (9); 11.3 km SE of Glamis, Algodones Dunes, 32°55'20" N, 114°59'14" W, Site 4 (12); 6.5 km W of Ogilby, 32°48'48" N, 104°53'51" W (1); 6.4 km SSW of Ogilby, 32°45'33" N, 104°51'32" W, Site 7 (3); Algodones Dunes, 4 km NE of Coachella Bridge No. 1, 32°51'41" N, 115°4'6" W, Site 24, (1); Algodones Dunes, 20 km ESE of Holtville, 32°44'34" N, 115°11'53" W, Site 30, (1). INYO Co.: Chicago Valley Sand Dunes (2). KERN Co.: 12.9 km N and 4.8 km W of Ridgecrest (1); 1.6 km E of Bakersfield Hart Peak (1). KINGS Co.: no locality (2); 7.7 km W of Kettleman City, 7.7 km W (8) of, and 3.2 km S of Leemoore. RIVERSIDE Co.: Hopkins Well (2); Palm Springs (1); Rice Dunes (13); Palen Dunes (16); 11.3 km SE of Freda (2); 4.8 km W of Blythe (7); 1.6 km W of Blythe (10); Indio (1); 8 km E of Indio (2); La Quinta (1); Mule Mts. (3); 3.2 km NW of Gilman Hot Springs, Lamb Canyon (9). SAN BERNARDINO Co.: Cadiz Dunes (33); Kelso Dunes (4); 28.2 km SE of Baker, Cronese Valley (2); 14.5 air km S of sand dunes S of Zzyzx (3); 14.5 km N and 16.1 km E of Ridgecrest (3); 16.1 km N and 16.1 km E of Ridgecrest (1); 9.7 km N and 3.2 km W of Ridgecrest (1); 30.6 km N of Ridgecrest, Baby Mt. (7); Amargosa River at st. hwy. 127 (1). SAN DIEGO Co.: Borrego (1). SAN LUIS OBISPO Co.: 12.1 km W of Simmler (18); 24.9 km NW of Reyes Station (1). SANTA CRUZ Co.: (1); Watsonville (1). NEW

MEXICO. (32 specimens/5 localities). Hot Springs (4). *LUNA Co.*: Deming (2); E of Deming at base of Red Mt. on Humocky Rd. (14). *SAN JUAN Co.*: Ship Rock (11). *SOCORRO Co.*: Sevilletta Sand Dunes (1). TEXAS. (4 specimens/2 localities). *EL PASO Co.*: El Paso (3). *PRESIDIO Co.*: Marfa (1). UTAH (55 specimens/5 localities). *JUAB Co.*: Fish Springs Range, 40.2 km SE of Callao, Sand Pass (4). *KANE Co.*: 8 km SE of Glen Canyon City, sand dunes (3); Lake Powell, Lone Rock Campgr. (27). *SAN JUAN Co.*: 3.2 km S and 32.2 km W of Bluff (10). *WASHINGTON Co.*: 17.9 km N of St. George, red sand dunes (1). MEXICO. *BAJA CALIFORNIA* (327 specimens/13 localities): Miller's Landing (84); 16.1 km S of Punta Prieta (2); 12. 4 km NW of Catavina (2); El Crusero (22); 41.4 km SE of Laguna Chapala (15); 19.3 km NW of San Bartolo (1); 9.7 km N of Guerrero Negro (154); 5 km N of Guerrero Negro (8); 11.3 km N of Guerrero Negro (6); 25.7 km E of Rosarito, Rancho San Ignacito (22); 10 km NE of Rosarito (9); 5.0 km SW of Colonet (1); Bahia San Quintin, Santa Maria Beach (1). *BAJA CALIFORNIA SUR* (96 specimens/8 localities): 22.5 km E of Guerrero Negro (1); 55.4 km SE of Guerrero Negro (4); 13.7 km ESE and 8.6 km S of Guerrero Negro (2); 11.3 km SE of Guerrero Negro (27); 20.9 km SW of Guillermo Prieto (43); 19.3 km S of Guillermo Prieto (10); 20.9 km S of Rancho Tablon (8); Tortugas (1). *COAHUILA* (42 specimens/1 locality): 12.9 km N of Viesca, sand dunes at Bilbao (42). *DURANGO* (26 specimens/1 locality): 43.5 km S of Ceballos (26). *SONORA* (12 specimens/7 localities): Puerto Penasco, 0.5 km from coast (1); Desemboque (1); El Golfo (4); 80. 5 km SW of Sonoyta (1); 16.1 km N of C. Sotelo nr. Bahia Adair (1); San Carlos Bay (1); 9.7 km W of San Carlos Bay, Los Agodones (3).

PHYLOGENETIC CONSIDERATIONS

Pseudorostus and *Eurostus* have historically either been separated from *Niptus* (Brown 1940: 119, 1944: 19, 1959: 627; Hinton 1941: 343; Spilman 1968: 193) or included as synonyms of *Niptus* (Papp 1959: 258, 1962: 385; Spilman [North American Beetle Fauna Project] 1975: R62-1). Of these, *Eurostus* has generally been accepted as being congeneric with *Pseudeurostus*. *Pseudeurostus* has been separated from *Niptus* based on the carinate frons between the antennal fossae in *Pseudeurostus* (Fig. 12), which is not narrowly flat as in *Niptus* (Fig. 11). Clearly, this character is unique and synapomorphic in species of *Pseudeurostus*. However, *P. hilleri* and *P. kelleri* and all species of *Niptus* except *N. hololeucus* (Fig. 15) share a strongly reduced fourth visible abdominal sternite (Figs. 17, 21), another clearly synapomorphic character. Thus, if *Pseudeurostus* is to be generically separated from *Niptus*, then *N. hololeucus*, the type species of *Niptus*, needs also to be separated from both groups, making it necessary for a new generic name for the eight "wild" species of *Niptus*. It is clearly preferable to lump all these under the genus *Niptus* as indicated by Spilman (1975: R62-1).

KEY TO NORTH AMERICAN SPECIES OF *NIPTUS*

- 1. Body large (usually above 3.8 mm in length), golden throughout, color result of scale-like setae that completely conceal integument of entire insect; fourth visible abdominal sternite only slightly shorter than third (Fig. 15); pronotum lacking distinct tufts of setae (Fig. 10) *hololeucus*
- 1'. Body smaller (usually under 3.4 mm in length), red-brown above, elytra not completely covered with scale-like setae; fourth visible abdominal sternite less than one-half length of third 2
- 2(1'). Frons carinate between antennal fossae (Fig. 12); pronotum lacking distinct transverse row of four tufts of setae (*Pseudeurostus* group) 3
- 2'. Frons narrow but flat between antennal fossae (Figs. 11, 13); pronotum with distinct transverse row of four tufts of setae (Fig. 18) 4

- 3(2). Elytral intervals with closely placed, recumbent setae as well as single row of semi-erect setae *kelleri*
- 3'. Elytral intervals with single row of semi-erect setae, lacking closely placed, recumbent setae (Fig. 12) *hilleri*
- 4(2'). Antennal fossa with dorsal border distinctly carinate and laterally strongly elevated (Figs. 13, 16) 5
- 4'. Antennal fossa with dorsal border not distinctly carinate and laterally not strongly elevated (Fig. 11). 7
- 5(4). Elytra with strial punctures deeply impressed, large, contiguous, equal in size and impression throughout; erect setae on intervals one to five short; legs with metafemur clavate, very stout; eyes small (Fig. 8) *sleeperi*
- 5'. Elytra with strial punctures unevenly impressed, always fine to minute at apex and lateral margins; erect setae on intervals three and five long to moderately long; legs with metafemur clavate; eyes variable 6
- 6(5'). Elytra with erect setae on intervals three and five long; short on intervals one, two and four; strial punctures often large and deeply impressed on disc; eyes large (Figs. 5, 22) *ventriculus*
- 6'. Elytra with erect setae on intervals three and five only slightly longer than those on intervals one, two and four, strial fine to minute; eyes smaller (Fig. 6) *abstrusus*
- 7(4'). Elytra with length of erect setae on intervals three and five greater than width of one interval; pronotal tufts not equal in size; eyes variable 8
- 7'. Elytra with length of erect setae on intervals three and five less than width of one interval; pronotal tufts equal in size; eyes very small 9
- 8(7). Pronotum with medial transverse pronotal setal tufts more developed than lateral pronotal setal tufts; anterior margin of pronotum with long erect setae; elytra with erect setae absent on intervals on two and four; legs with metafemur clavate, metatibia stout, strongly curved; eyes large; sternites sexually dimorphic (Fig. 3) *giulianii*
- 8'. Pronotum with lateral transverse tufts more developed than medial pronotal setal tufts; anterior margin of pronotum lacking long erect setae; elytra with erect setae short but present on two and four; legs with metafemur capitate, metatibia slender, straight; eyes small; sternites not sexually dimorphic (Fig. 4) *abditus*
- 9(7'). Erect setae on elytra spatulate at tip (Figs. 1, 2); width of metatibiae variable 10
- 9'. Erect setae on elytra unmodified, pointed at tip; width of metatibiae at apex equal to widths of eighth and ninth intervals combined (Fig. 7) *absconditus*
- 10(9). Erect spatulate setae on elytra very short; legs short, stout, metafemora clavate (as in Fig. 20), width of metatibia at apex equal to widths of eighth and ninth intervals combined (Fig. 2) *neotomae*
- 10'. Erect spatulate setae on elytra short (Fig. 1); legs long, slender, metafemora capitate (Fig. 19), width of metatibia at apex subequal to widths of eighth and ninth intervals combined *arcamus*

BIOLOGY

North American species of *Niptus* not associated with stored products seem to be distributed in two seemingly different habitats: caves and sand dune areas. These two habitats do share one important aspect of the microhabitat in which *Niptus* species are found. This is a fine to very fine substrate (in the form of fine sand or cave dust) with a varying amount of organic debris due to rodent activity. All species seem to be associated with various desert rodents especially species of packrats (*Neotoma*), but also mice (*Peromyscus*), and kangaroo rats (*Dipodomys*).

Niptus arcanus, *N. abstrusus*, *N. absconditus*, and *N. kelleri* are found in caves. These reveal to varying degrees, morphological characteristics typically associated with cave coleoptera (see Aalbu 1990). Of these *N. arcanus*, *N. kelleri* and *N. absconditus* are restricted to single cave habitats. *Niptus arcanus* is considered to be a true troglobite (Aalbu 1990) a relative rarity in Northwestern American beetles. It is possible that upon further study, other species will also be classified as troglobites rather than troglaphiles. We can only stress the importance of conserving these unique cave habitats, especially in caves where considerable environmental impact is present due to high visitor traffic (such as in Mitchell Caverns). This would entail assuring species survival by providing for long term microhabitat protection in terms of the least amount of habitat disturbance possible.

ACKNOWLEDGMENT

The following individuals and institutions are gratefully acknowledged for loan of their material: David Kavanaugh, California Academy of Sciences, San Francisco, California; John T. Doyen, University of California, Berkeley, California; Ives Bousket, Canadian National Collection, Ottawa, Ontario, Canada; E. L. Sleeper, California State University, Long Beach, California; Al Newton, Field Museum of Natural History, Chicago, Illinois; Kirby W. Brown, Stockton, California; Scott Shaw, Harvard University Museum of Comparative Zoology, Cambridge, Massachusetts; Charles A. Triplehorn, The Ohio State University, Columbus, Ohio; Dave Faulkner, San Diego Museum of Natural History, San Diego, California; Ted J. Spilman, United States National Museum, Washington D.C.; Carl A. Olson, University of Arizona, Tucson, Arizona. The following individuals deserve special mention: Ives Bousket of The Canadian National Collection for loan of paratype of *N. abditus*; Phillips L. Claud, Jim Hart, Bill Wisheart and John Kelso-Shelton of the California Department of Parks and Recreation, for granting collection permits and aiding in collections of *N. arcanus*.

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Received 1 May 1990; accepted 15 July 1991.

**THE SOLITARY BEE
MELISSODES THELYPODII THELYPODII COCKERELL
(HYMENOPTERA: ANTHOPHORIDAE) COLLECTS
POLLEN FROM WIND-POLLINATED
AMARANTHUS PALMERI WATSON**

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Abstract.—The native solitary bee *Melissodes thelypodii thelypodii* Cockerell was observed to harvest pollen from panicles of the anemophilous plant *Amaranthus palmeri* Watson in southeastern Arizona. Pure *Amaranthus* pollen loads were removed by females foraging at this plant, suggesting floral fidelity and this bee's potential value for commercial pollination of the related grain amaranths.

Key Words.—Insecta, pollination, anemophily, *Melissodes*, *Amaranthus*, pollen-foraging, bees

Foragers of social bees will sometimes collect pollen from flowering plants that rely upon wind to transport pollen to receptive pistils (Faegri & van der Pijl 1978). Honey bees (*Apis mellifera* L.) and sometimes stingless bees (*Trigona* s.l.) collect pollen from diverse anemophilous (wind-pollinated) plants (Sharma 1970; O'Neal & Waller 1984; C. D. Michener, unpublished data). Less commonly, bumble bees (*Bombus* sp.) may collect pollen from anemophilous plants, such as bahia grass, *Paspalum notatum* var. *saurae* Parodi (JHC, unpublished data).

In contrast, nonsocial or solitary bees have rarely been reported to gather pollen from anemophilous plants. The pollen of oaks (*Quercus*), which are considered anemophilous, may be gathered by solitary bees when their preferred pollen hosts are not available (*Andrena erythronii* Robertson [Michener & Rettenmeyer 1956]; *Osmia rufa* [Raw 1974]; *Habropoda laboriosa* (Fabr.) [Cane & Payne 1988]). Several British *Andrena* reportedly collect pollen periodically from several anemophilous trees, such as oak and chestnut (Chambers 1945). Nomiine bees of the Old World genus *Rhopalomesia* collect and may depend on grass pollen for larval provisions (C. D. Michener, unpublished data). The sweat bee *Dialictus illinoensis* (Robertson) avidly harvests pollen from dallis grass, *Paspalum dilatatum* Poiret, augmenting the seed set of this grass (Adams et al. 1981).

Careless-weed (*Amaranthus palmeri* Watson) is a weedy, dioecious amaranth occurring through much of the central and western United States and Mexico (Munz 1959). The species exhibits several characteristics that typify anemophilous plants. It produces copious pollen that bears little of the oily pollenkitt typical of pollen usually collected by bees. Its small (24–26 μm diam) periporate "cheno-am" (Chenopodiaceae–Amaranthaceae) type pollen grains are commonly implicated in human hayfever allergies (Wodehouse 1971). Bees have not been reported to visit this anemophilous plant.

We observed female *Melissodes thelypodii thelypodii* Cockerell working the spike-like panicles of male plants of *A. palmeri* for pollen during mornings of August, 1990, along the edge of a cotton field in the San Simon Valley of southeastern Arizona (Cochise Co.). In this vicinity, we previously noted this bee species sonicating flowers of *Solanum elaeagnifolium* Cavanilles and *S. rostratum* Dunal (Solanaceae) for pollen. Bees of other species that worked nearby *Solanum* flowers were never seen at *Amaranthus* (*Protoxaea gloriosa* (Fox), *Protandrena mexicana-norum* (Cockerell), *Bombus sonorus* Say, and *Caupolicana yarrowi* (Cresson)).

The first female *M. thelypodii thelypodii* to visit a given inflorescence frequently released a visible cloud of pollen upon alighting. Females walked along the spikes gathering pollen, proceeding distally from mid-base along those spikes that were upright. They would then fly to a neighboring spike to continue collecting pollen. Some females accumulated a full load of *Amaranthus* pollen from five to seven spikes in as few as six minutes. A microscopic survey of the taxonomic constitution of their pollen loads revealed good floral fidelity. Pure loads of *Amaranthus* pollen were carried by five of six females collected at *Amaranthus*. The remaining female bore 11% cotton pollen and 89% *Amaranthus* pollen. We have found only one other reference to species of *Melissodes* gathering pollen from anemophilous plants. Adams et al. (1981) reported *M. bimaculata* (Lepeletier) to occasionally collect pollen from dallis grass.

The role, if any, of bees in the pollination of dioecious anemophilous plants has been debated in the pollination literature. Usually, solitary or social bees that harvest anemophilous pollen are considered mere pollen thieves, removing pollen from male plants but never subsequently visiting the nectarless female plants. Their contribution to pollination can not be discounted, however. Foragers may mistakenly visit female flowers upon occasion. Even if they only visit male flowers, wing and leg movements during pollen collection may dislodge prodigious quantities of pollen which, once airborne, can travel to female flowers.

The relative contributions of wind and insects, specifically bees, to the pollination of wild and cultivated amaranths also remains equivocal. Several weedy species have been implicated in human respiratory allergies, including *A. palmeri* (Wodehouse 1971). Unlike many anemophilous pollens, such as conifer pollen, the pollen of *A. palmeri* seems to be moderately nutritious for bees, containing 3.5% nitrogen, or 18.38% crude protein by micro-Kjeldahl analysis (SLB, unpublished data). Bee activity varies greatly at amaranths. Kaufman (1979) reported an absence of bees at cultivated grain amaranth. In contrast, Singh (1961) sometimes observed abundant bees at grain amaranth in India, and O'Neal & Waller (1984) found *Amaranthus* pollen to constitute 6% of the average annual pollen intake of honey bee colonies in the Sonoran desert, near Tucson, Arizona. Using pollen traps on honey bee colonies, one of us (SLB) found that cheno-am pollen constituted from 2–8% of the annual colony pollen harvest near Tucson during the years 1981–1989. The solitary bee *Hylaeus bisinuatus* Forster has been recorded visiting members of the Amaranthaceae (Krombein et al. 1979). We conclude that amaranth pollen is not a mere scopal contaminant in these cases. Bees will actively collect amaranth pollen, perhaps reflecting the ease with which quantities of this pollen can be harvested relative to other competing floral species.

For *Amaranthus retroflexus* L., Murphy (1978) demonstrated that insects alone could provide cross-pollination. Further, Hauptli & Jain (1985) found wide dis-

parities in outcrossing rates for their field experiments with cultivated *Amaranthus cruentus*. They attributed this result to variable densities of pollen-foraging honey bees in their plots.

Our observations demonstrate that females of the solitary bee *M. t. thelypodii* avidly visit staminate flowers of amaranth for pollen, exhibiting good species fidelity on a given foraging trip. For at least hermaphroditic species of commercial amaranth, the visitations of pollen-foraging bees have promise to improve outcrossing rates for the enhancement of genetic variation and perhaps even seed set of desirable cultivars.

ACKNOWLEDGMENT

Voucher bees are deposited with the Illinois Natural History Survey. This article is contribution number 17-912991P of the Alabama Agricultural Experiment Station, which partly supported this research (H-803).

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Received 17 May 1991; accepted 13 August 1991.

**SPHERICAL HYPHAL BODIES OF *PANDORA NEOAPHIDIS*
(REMAUDIÈRE & HENNEBERT) HUMBER
(ZYGOMYCETES: ENTOMOPHTHORALES) ON
ACYRTHOSIPHON PISUM (HARRIS)
(HOMOPTERA: APHIDIDAE): A POTENTIAL
OVERWINTERING FORM**

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Abstract.—Cadavers of the pea aphid, *Acyrtosiphon pisum* (Harris), occurred abundantly on commercial alfalfa in Kennewick, Washington, during late autumn of 1990. An aphid-specific fungal pathogen, *Pandora neoaphidis* (Remaudière & Hennebert) Humber, was responsible for the death. Numerous hyphal bodies of the fungus inside the cadavers were spherical and averaged 11.5 (9.3–15.0) μm in diameter ($n = 100$). Such spherical hyphal bodies apparently developed from regular hyphal bodies forming septa, which has never been recorded for *P. neoaphidis*. Over 300 cadavers collected in the field on 15 Oct were randomly sorted into three batches and then maintained under different environmental conditions for studying the overwintering potential of the fungus. Cadavers maintained in a dark refrigerator at approximately 4° C or placed within nylon-chiffon mesh bags (ca. 5 \times 5 mm) and secured to the branches of shrubs (approximately 0.5 m above the ground in Bozeman, Montana) were capable of producing conidia and infecting aphids in monthly observations from November to April with consistently visible snow cover. In contrast, cadavers placed in polypropylene microcentrifuge tubes (38 \times 13 mm), corked with sterile cotton and then buried in the field soil (approximately 6 cm deep), were found to have exhausted all their sporulation potential and infective capability in the first observation of late November. The results indicate that *P. neoaphidis* may survive winter months in the form of hyphal bodies on plant substrates above the ground rather than in the soil.

Key Words.—Insecta, *Acyrtosiphon pisum*, Entomophthorales, *Pandora neoaphidis*, aphid-specific fungal pathogen, overwintering

A mycosis of the pea aphid, *Acyrtosiphon pisum* (Harris) (Homoptera: Aphididae), was observed in a commercial alfalfa field in Kennewick, Washington, during late September through mid-October, 1990. Alfalfa stems were heavily infested with aphids (100% of the plants infested and more than 100 aphids per alfalfa stem). Aphid cadavers, resulting from fungal infection, were observed in abundance. Approximately 10% of the axillary shoots on alfalfa stems contained at least one cadaver, and some of the shoots contained 10 or more.

Aphid cadavers collected on 27 Sep, 1 Oct and 9 Oct (the last date coinciding with alfalfa harvest) were shipped via overnight mail to MGF in Bozeman, Montana, for identification of pathogens involved. The aphid-specific fungus, *Pandora neoaphidis* (Remaudière & Hennebert) Humber (Zygomycetes, Entomophthora-

les), was found to be the only pathogen responsible for the mycosis observed. This was based on microscopic examination of nearly 200 cadavers individually mounted on slides with aceto-orcein following maintenance in a moist chamber at approximately 25° C for 20 h. No secondary infection by other entomophthoralean fungi was detected.

Morphological features including conidiophores, conidia (Fig. 1a) and hyphal bodies (Fig. 1b) coincided well with those previously documented for *P. neoaphidis* (e.g., Feng et al. 1990). Measurements of 100 primary conidia randomly taken from 20 slides (cadavers) averaged 22.0 (17.5–27.5) × 11.3 (9.25–14.3) μm, falling within the previously defined range of *P. neoaphidis* (Waterhouse & Brady 1982).

Spherical hyphal bodies (SHB) (Figs. 1c, 1d, 1h), not previously documented for *P. neoaphidis*, appeared with primary conidia and regular hyphal bodies (RHB) in all the cadavers examined. The relative abundance of these unusual hyphal bodies seemed to be negatively correlated with the abundance of primary conidia and RHBs. Some of the cadavers were nearly filled with SHBs. The frequency of cadavers containing SHBs tended to increase with each successive collection date.

The SHBs measured 11.5 (9.3–15.0) μm in diameter ($n = 100$), and were nearly equal to the diameter (width) of primary conidia (Fig. 1a) and RHBs (Fig. 1b). Like uninucleate primary conidia of *P. neoaphidis*, most SHBs contained only a single large nucleus (Fig. 1c). Some SHBs were found to have two or more nuclei (Fig. 1d). SHBs with multiple nuclei were usually larger in size than those with only one nucleus.

The SHBs apparently developed from RHBs, as shown in Figs. 1e–1h. A septum sometimes appeared in the hyphal body, preceding the formation of a SHB (Figs. 1e–1g). Septa are usually absent from the vegetative cells in the Entomophthoraceae (Humber 1989) and have never been recorded for *P. neoaphidis*. Subsequently, the single cell separated by a septum became spherical, often at the end of the hyphal body (Fig. 1g). Eventually, the remainder of the hyphal body gradually disappeared as its contents (protoplasts) entered the new SHBs (Fig. 1h).

The appearance of SHBs late in the season suggests that SHBs may function as an overwintering form in the life cycle of *P. neoaphidis*. This hypothesis was tested by tracing the infectivity of cadavers collected from the field, then exposed to different environments during winter months. Over 300 cadavers were collected from uncut alfalfa plants on the border strips of the field in Kennewick on 15 Oct and carried back to the laboratory in Bozeman. These cadavers were then separated into 3 batches and about 15 from each batch were placed into polypropylene microcentrifuge tubes (38 × 13 mm) corked with sterile cotton for two batches or nylon-chiffon mesh bags (approximately 5 × 5 cm; four threads per mm) for the third batch. The two batches of tubes were maintained in a dark refrigerator of about 4° C and buried in the field soil (approximately 6 cm deep) on the Montana State University campus, respectively. Mesh bags of the third batch were secured to the branches of outdoor shrubs approximately 0.5 m above the ground on the university campus. Thereafter, one tube or bag of cadavers was randomly taken from each batch every month and used to inoculate aphids reared in the laboratory by suspending the cadavers over the aphids for a spore shower. It was found that cadavers hung in bushes or maintained in the refrigerator were capable of producing conidia and infecting aphids throughout the cold winter with consistently visible snow cover from November to April. However, cadavers in the tubes

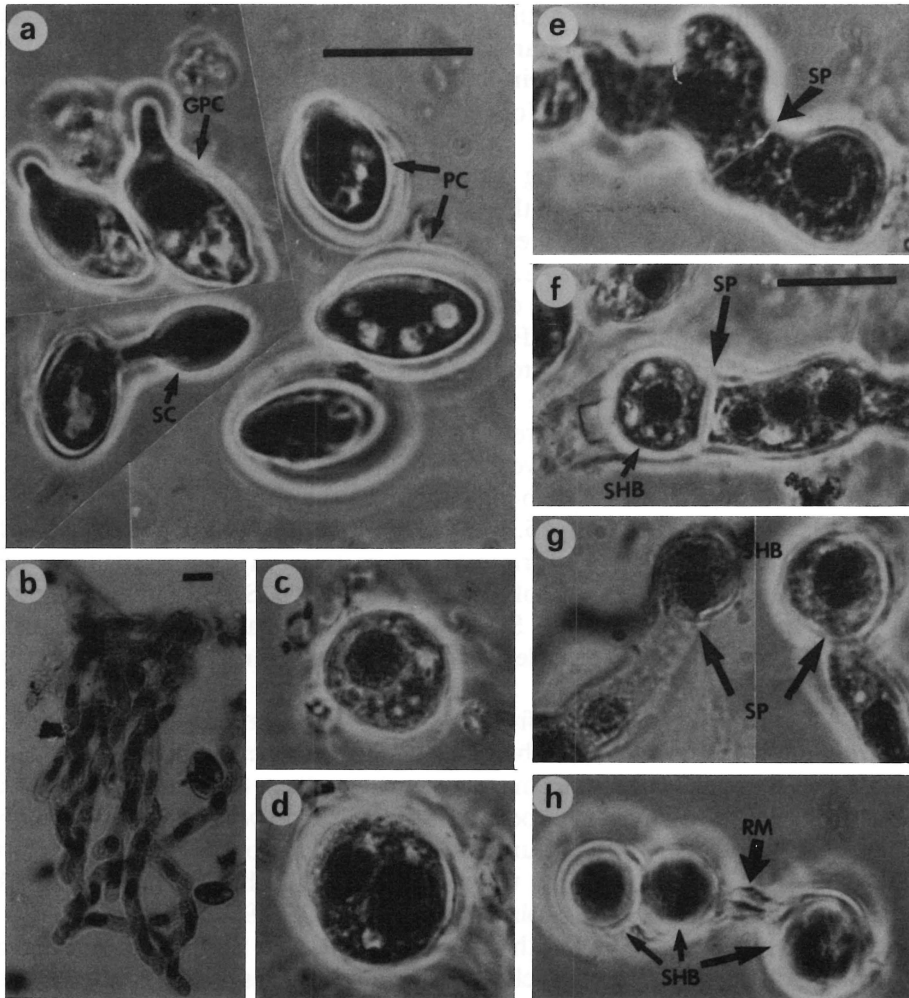


Figure 1. Common morphological characteristics (a, b) and unusual spherical hyphal bodies [SHB] (c–h) of *P. neoaphidis* associated with cadavers of *A. pisum* on alfalfa in Kennewick, Washington, in autumn. (a) Primary conidia [PC], germinating PC [GPC] and secondary conidium [SC] formed from PC. (b) Regular hyphal bodies [RHB]. (c) SHB uninucleate. (d) SHB binucleate. (e, f) Well-defined septum [SP], at arrow, seen in RHB. (g) SHB forming at the end of RHB. (h) Newly-formed SHB and remains [RM] of RHB. Scale bars: 20 μ m; the bar for (a) also applies to (c–e) and (g, h).

buried in the soil were found to have exhausted all their sporulation potential in the first observation on 30 Nov. A layer of conidia were then visible on the inside wall of the tube and the cadavers became indistinguishable from one to another. As a result, the cadavers in the soil could not infect aphids at that time. This appeared to be attributable to the high humidity in the soil under snow cover during the relatively mild November.

Therefore, our observations indicate that the *P. neoaphidis* hyphal bodies in aphid cadavers can survive winter months only in relatively dry environments

(e.g., on plant substrates above the ground) rather than in the moist soil, as postulated by some authors (e.g., Latteur & Godefroid 1983). This is similar to a report that hyphal bodies of *P. neoaphidis* may maintain infectivity in cadavers for up to 32 weeks at regimes of 0° C and $\leq 50\%$ relative humidity (Wilding 1973). In contrast, other entomophthoralean fungi generally overwinter as resting spores, as seen in *Conidiobolus obscurus* (Hall & Dunn) Remaudière & Keller (Latzgé et al. 1978) and *Zoophthora radicans* (Brefeld) Batko (Perry & Régnière 1986). Although it was claimed that resting spores of *P. neoaphidis* had been obtained in vitro (Uziel & Kenneth 1986), resting spores have never been observed from aphids infected by *P. neoaphidis* in the field. The SHBs observed in this study are unlikely to be resting spores (zygospores or azygospores) because they are thin-walled and too small for resting spores typically reported for the Entomophthorales (R. A. Humber, personal communication). Resting spores have been observed in the field for another entomophthoralean species, *Entomophthora planchoniana* Cornu, but the primary overwintering form of this latter fungus is hyphal bodies that are distinct from those usually found for the same species (Keller 1987). SHBs in the pea aphids infected by *P. neoaphidis* late in the season seem to be analogous to the hyphal bodies of *E. planchoniana*.

It remains unknown what environmental stimuli may induce the information of septa in the hyphal bodies, thus forming the SHBs. During the period from 16 Sep to 15 Oct, 1990, local day length decreased from about 12.5 h to 11 h, while the daily minimum temperature was 9.3 (range: 1.1–16.1)° C, daily maximum 22.4 (10.6–30.6)° C, and daily mean 15.7 (7.8–22.8)° C. Whether these environmental conditions (short day and low temperature) may be conducive to physiological changes in the aphid hosts, which in turn may influence fungal development, is unclear.

Finally, *P. neoaphidis* may require a variety of host species from different crops or non-crop plants to complete the life cycle. Plant hosts that remain in the field through late autumn or are perennial (e.g., alfalfa) may provide a source of inoculum to initiate infections in aphid populations that infest spring and summer crops the following year (e.g., small grains). This hypothesis warrants further studies.

ACKNOWLEDGMENT

We thank R. A. Humber, S. A. Woods and D. A. Streett for their critical review of this manuscript. This article is published as Journal Series No. J-2587 from the Agricultural Experiment Station, Montana State University, Bozeman, Montana.

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Received 25 June 1991; accepted 13 August 1991.

**RECENT COLONIZATION OF THE
SAN FRANCISCO BAY AREA, CALIFORNIA,
BY EXOTIC MOTHS (LEPIDOPTERA: TINEOIDEA,
GELECHIOIDEA, TORTRICOIDEA, PYRALOIDEA)**

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Abstract.—Records are given documenting the establishment of seven species of moths in the San Francisco Bay area, California, during 1955–1988: *Opogona omoscopia* (Meyrick) (Tineidae), *Oegoconia quadripuncta* (Haworth) (Blastobasidae), *Mirificarma eburnella* (Denis & Schiffermüller) (Gelechiidae), *Crociosema plebiana* Zeller (Tortricidae), and three pyraloids, *Uresiphita reversalis* (Guenée), *Parapediasia teterella* (Zincken), and *Achroia grisella* (Fabr.). Ten additional Microlepidoptera that have colonized this region in the past 50 years are tabulated with literature sources. Most of these species spread to the San Francisco area after establishment in southern California, often following long periods (17–60 years) of naturalization there.

Key Words.—Insecta, Lepidoptera, Tineoidea, Gelechioidea, Tortricoidea, Pyraloidea, colonization

Insects make up an important part of the alien fauna that has been transported by humans to colonize different parts of the world. By 1982, 1700 such immigrants had become established in the 48 contiguous U.S. states, including 134 Lepidoptera (Sailer 1983). Although Sailer calculated that Lepidoptera are poorly represented, relative to their species numbers, as contrasted to Coleoptera, Hymenoptera and particularly Homoptera, some Microlepidoptera and Pyraloidea have become frequent travelers via their association with human activities.

California is an adopted home to more than 60 species of these smaller moths, including many of our most notorious insects, in households (clothes moths, stored foods moths), gardens (e.g., azalea leafminer, buddleia budworm, cotoneaster webworm), and agricultural situations (codling moth, Oriental fruit moth, pink bollworm, etc.). Other species are detritivores, scavengers, or fungus feeders and seldom attract attention. For example, *Opogona omoscopia* (Meyrick), *Nemapogon granellus* (L.), *Oinophila v-flavum* (Haworth), *Batia lunaris* (Haworth), *Endrosis sarcitrella* (L.), and *Oegoconia quadripuncta* (Haworth) are all common members of the urban insect community in California but are seldom noticed except by lepidopterists. A few adventive colonists are even encouraged for possible weed suppression, such as *Agonopteryx alstroemeriana* (Clerck), a specialist on poison hemlock, and *A. nervosa* (Haworth) and *Uresiphita reversalis* (Guenée), which feed on genista and other brooms, although the last species sometimes eats other ornamental legumes or native lupines and causes mixed emotions, varying with circumstances.

Many of these lepidopterous colonists became established in California so early in the immigration of European and Oriental humans that a history of their introduction and spread cannot be reconstructed. There is essentially no record

of the Microlepidoptera fauna of the Pacific coast of North America prior to the remarkable expedition in 1871–1872 in northern California and Oregon by Lord Walsingham, during which he collected and later described many of our native species (see Essig 1941, Powell 1964a: 5). More extensive collections in urban and agricultural situations were made by Koebele and Coquillett during the 1880s and 1890s, primarily in Alameda and Los Angeles counties. Otherwise, there are few records of Microlepidoptera in California prior to the turn of the century, and any other record that may have existed of the fauna in the San Francisco Bay area during the 19th century was lost in the 1906 fire that destroyed the collections of the California Academy of Sciences.

Despite federal and state efforts at quarantine against imported insects, as the human population has increased and ease of transportation improved, the parade of incoming insects has continued. California's population increased an appalling 25%, and that of the S. F. Bay area 16%, during the 1980s alone. Hence, it is not surprising that at least 17 species of small moths have taken up residence in this area during the past half century (Table 1). Included are six species that appear to have colonized during the 1980s. The occurrence of two of these is documented elsewhere: *Athrips rancidella* (Powell 1985) (Fig. 4) and *Agonopteryx alstroemeriana* (Powell & Passoa in press). Here, I give data for the remaining five, and for three species that have been established for longer periods, but apparently not documented in detail in the literature.

Methods.—I recovered data from specimens in the major California collections through 1990, by searching the unidentified accessions and confirming identifications in the determined material. Voucher specimens in collections are indicated in the text by the following abbreviations:

CAS, California Academy of Sciences, San Francisco; CDFA, California Department of Food & Agriculture, Sacramento; EME, Essig Museum of Entomology, University of California, Berkeley; FAC, Fresno County Agricultural Commissioner's Office, Fresno; LACM, Los Angeles County Museum of Natural History; SDNH, San Diego Natural History Museum; SJAC, San Joaquin County Agricultural Commissioner's Office, Stockton; SJS, San Jose State University, Department of Entomology; UCD, University of California, Davis, Bohart Entomological Museum; USNM, U.S. National Museum of Natural History, Washington, D.C. In addition, card- and computer-file records at CDFA were made available. Most of these are not represented by voucher specimens. Data from the identified material in the USNM were recorded, but not from unidentified accessions, through 1977 (*Opogona*, *Oegoconia*, *Achroia*) and 1988 (*Crocidosema*).

I made blacklight trap collections in suburban sites at Walnut Creek, Contra Costa Co., from 1961 to 1973 (EME). In the first six years, samples were made most nights I was in residence, near the foot of Shell Ridge, while those during August, 1966, to 1973 were sporadic, at a site near San Ramon Creek. The two localities are respectively about 2.75 airline km NW and 2.5 km SW of the Highway 24-680 interchange. I recorded moths in urban Berkeley on nearly all dates I was residence from May 1978 through 1990. During 1978–June, 1984, I sampled at a site 3.0 airline km NNW of the University of California west gate and during July 1984 through 1990, at a second locality 0.33 airline km north of the 1978–1984 site. This area has been residential since 1915–1920.

Table 1. Exotic Microlepidoptera and Pyraloidea that became established in the San Francisco Bay area during 1939–1988. (l = local colonization; w = widespread occurrence in S. F. Bay area; u = uncertain status.)

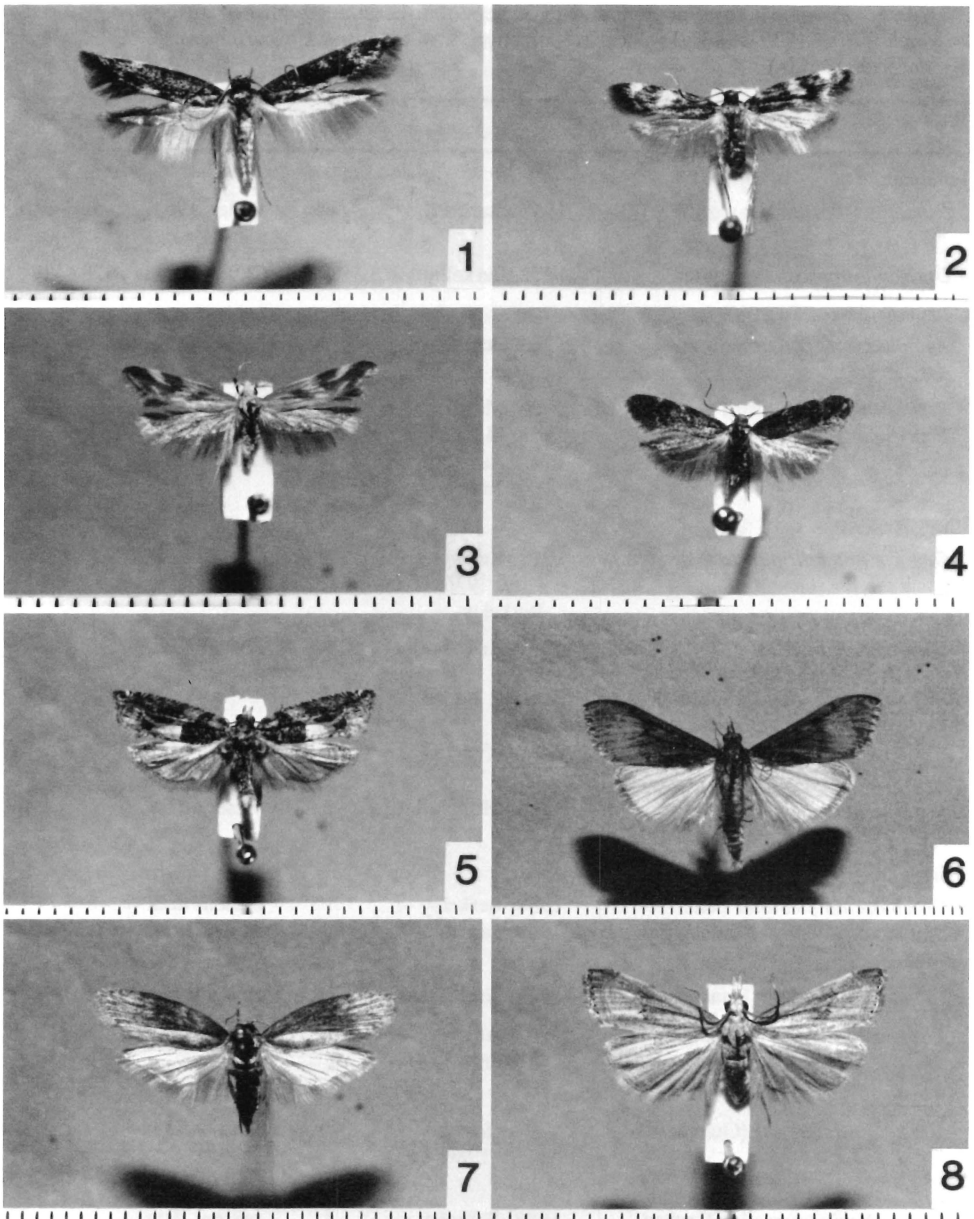
Taxa	Earliest record	Present status	Source
Tineidae:			
<i>Oiophila v-flavum</i> (Haworth)	1947, Stanford	w	Tilden 1951, Powell 1964b
<i>Opogona omoscopia</i> (Meyrick)	1972, Berkeley	w	CDFA, Davis 1978
Oecophoridae:			
<i>Agonopteryx alstroemeriana</i> (Clerck)	1983, Berkeley	w	Powell & Passoa, in press
<i>Battia lunaris</i> (Haworth)	1956, Marin	w	Powell 1964c
<i>Esperia sulphurella</i> (Fabr.)	1966, El Cerrito	l	Powell 1968
<i>Pyramidobela angelarum</i> Keifer	1942, San Jose, San Mateo	w	Keifer 1942
Blastobasidae:			
<i>Oegoconia quadripuncta</i> (Haworth)	1959, Redwood City, 1976, Berkeley	w	present data
<i>Symmoca signatella</i> (Herrich-Schaeffer)	1959, Redwood City	w	Powell 1960
Gelechiidae:			
<i>Athrips rancidella</i> (Herrich-Schaeffer)	1983, Berkeley	l	Powell 1985
<i>Mirificarma eburnella</i> (Denis & Schiffermüller)	1985, Morgan Hill	u	present data
Tortricidae:			
<i>Crociosema plebiana</i> Zeller	1988, Berkeley	l	present data
<i>Spilonota ocellana</i> (Denis & Schiffermüller)	1939, San Jose	w	Keifer 1939
<i>Cnephasia longana</i> (Haworth)	1947, San Mateo	w	Keifer 1948, Powell 1964a
<i>Platynota stultana</i> (Walsingham)	1967, Antioch, Albany	w	Powell 1983
Pyralidae:			
<i>Uresiphita reversalis</i> (Guenée)	(1966, Stevens Cr.), 1980, San Jose	w	present data
<i>Parapediasia teterrella</i> (Zincken)	1988, Berkeley	l	present data
<i>Achroia grisella</i> (Fabr.)	1955, San Jose	w	present data

TINEIDAE

Opogona omoscopia (Meyrick)

(Fig. 1)

Opogona omoscopia was originally described from Australia in 1893 and since has been found widely distributed in pan-global warm regions, probably in large part the result of man's activities. The larvae feed in decaying, often damp plant



Figures 1–8. Figure 1. *Opogona omoscopa*; Berkeley, October 1978. Figure 2. *Oegoconia quadripuncta*; Berkeley, June 1988. Figure 3. *Mirificarma eburnella*; Nevada Co., May 1980. Figure 4. *Athrips rancidella*; Berkeley, May 1983. Figure 5. *Crociosema plebiana* Zeller; Berkeley, November 1990. Figure 6. *Uresiphita reversalis*; Berkeley, December 1983. Figure 7. *Achroia grisella*; Berkeley, August 1983. Figure 8. *Parapediasia teterella*; Berkeley, May 1989.

material, including wood, bark and dead leaves (Davis 1978) and evidently are easily transported with roots and other plant material. This species has been known in Hawaii since 1905, where it is widespread and abundant (Zimmerman 1978), a likely source for introduction into California.

The earliest Pacific coast record is at Goleta, Santa Barbara Co., California, in May, 1969 (CDFA and Davis 1978), which probably was soon after establishment, because the adults come to lights readily, and I collected at Goleta for five weeks during June and July, 1965, without finding *O. omoscopia*. The moths were taken at nearby Santa Barbara and Summerland in June and July, 1969 (USNM). In fall, 1970, C. Nagano collected a series at Santa Monica, Los Angeles Co. (LACM), and by summer, 1971, *O. omoscopia* was widespread in southern California, having been detected in Gardena (LACM), Los Angeles (USNM) and Rancho Santa Fe, San Diego Co. (EME).

The first records in the S. F. Bay area were two larval collections on ginger roots in a market in Berkeley, in May, 1972, and May, 1973 (CDFA). Ginger roots sold in this area are normally imported from Hawaii. Hence, it is possible that a separate introduction from overseas, rather than from southern California, initiated the S. F. Bay area population. There also were larval collections from Corte Madera, Marin Co. in January, 1974, and Fremont and Livermore, Alameda Co. in 1976 (CDFA), but we do not have documented records of colonies outside of buildings until adults began appearing at lights in the 'east bay' in 1978 (EME). The species has been common in Berkeley since that time, having been recorded on 15–30 dates each year. The moths are seen in every month but are most prevalent in September–November (50% of all records during 1985–1990: JAP, unpublished data).

The peculiar, widely divergent labial palpi, flattened, smooth front and elongate, plicate maxillary palpi make *O. omoscopia* easily recognizable among all California Lepidoptera.

BLASTOBASIDAE

Oegoconia quadripuncta (Haworth)

(Fig. 2)

This Palaearctic species is distinctive in the urban fauna of California, having black forewings spotted with yellow. In Europe the larvae are reported to feed on decaying vegetable matter, and we reared *O. quadripuncta* from leaf litter beneath *Quercus* by P. Rude (EME). In England there is a single annual generation, with adults active in July and August, occurring in habitats such as hedge-bottoms (Emmet 1979).

Oegoconia quadripuncta was introduced into the Atlantic states long ago; it was redescribed as *novimundi* Busck, a synonym, in 1915, and it was established in Pennsylvania and New Jersey by 1920 (USNM). The adventive range had reached Washington, D.C. by 1927, Martha's Vineyard, Massachusetts by 1941 and Illinois by 1956 (USNM).

There does not seem to be a published report of this species' occurrence in California, such as during Keifer's summaries of introductions during 1935–1955 (Powell 1991). However, *O. quadripuncta* evidently was introduced into southern California, presumably from the eastern U.S., more than 50 years ago. There are specimens from South Pasadena, L. A. Co., collected in August, 1938, and June, 1940 by C. Henne (USNM), and the range extended to Ventura Co. (Ojai) by 1961 (EME) and Orange Co. by 1962 (CDFA). The species had become common in Los Angeles by the time Donahue began sampling there in the early 1970s (LACM).

The first record I have seen in the S. F. Bay area is August, 1959, at Redwood City, San Mateo Co. (EME), but *O. quadripuncta* was not known east of the bay until adults appeared at lights in Berkeley in 1976. The species seems to be becoming more prevalent at Berkeley; it was observed on two or three dates per season until 1986, then five dates in 1987 and 1988, six in 1989, and nine in 1990 (despite 44 nights absence from sampling during summer), when the flight period extended from early June to mid September.

Oegoconia evidently colonized the Central Valley about a decade later than the S. F. Bay area. I did not find the species in Davis when I sampled there in 1956, but there are more than a dozen collections records from Sacramento (1967–1968), Davis (1969–1971) and Fresno (1970–1971) (CDFA, UCD).

GELECHIIDAE

Mirificarma eburnella (Denis & Schiffermüller) (Fig. 3)

This moth was reported in North America under the names *M. formosella* (Hübner) (Anonymous 1969, Dowell & Gill 1989) and *M. flamella* (Hübner) (Hodges 1983), which are considered to be synonyms of *M. eburnella* (Pitkin 1984). The species is widespread in Europe and the Mediterranean region, where it feeds on *Medicago*, including alfalfa, and other legumes (Pitkin 1984).

This gelechiid is distinctive in the California fauna, having rust-orange and yellow patterned forewings. It was first recognized in North America when larvae were found defoliating Ladino clover, *Trifolium repens* L., in the Sacramento Valley in Sutter, Placer and Sacramento counties, in April, 1969. Identifications at the time revealed that I had collected specimens near Georgetown, El Dorado Co., in June, 1967 (Anonymous 1969; CDFa, unpublished report). The species was already widely established, however, as evidenced by specimens determined later that had been taken by A. Keuter and G. Keuter in May, 1965, and May–June, 1967, at Citrus Heights, Sacramento Co. (CAS). There are also two specimens labelled 12 Oct 1967, in the Keuter material, suggesting a bivoltine life cycle.

Berkeley students and I found *M. eburnella* at additional localities in El Dorado Co. (Greenville, Somerset) during May and June, 1967 and 1978, and at several sites around the Sierra Foothill Field Station (near Smartville), Yuba Co. and Rough and Ready, Nevada Co., in May, 1980. The species appeared at La Grange, Stanislaus Co. in 1971 (CDFa), at a site that has been sampled for many years by R. P. Allen. The 1971–1980 localities are 55 km NW to 134 km SE of a line between Citrus Heights and Georgetown, along the foothills of the Sierra Nevada.

During a census of Lepidoptera of serpentine grasslands in Santa Clara Co., D. D. Murphy and I collected two specimens of *M. eburnella* at Kirby Canyon Ridge (approx. 6 airline km NE of Morgan Hill), on 29 Apr 1985. This suggested that populations of this gelechiid had spread across the Central Valley and inner Coast Range into the Santa Clara Valley. However, more intensive survey on numerous dates at this locality and serpentine grasslands at a dozen other sites in Santa Clara, San Mateo and Marin counties during March through May, 1986–1987 and 1990 failed to recover *M. eburnella*. Possibly the four year drought following 1985 suppressed the clover or other hostplants severely, limiting or eradicating

the immigrant moth population from this habitat. Hence, the residency status of *M. eburnella* in the S. F. Bay area is uncertain.

TORTRICIDAE

Crocidosema plebiana Zeller

(Fig. 5)

This species was originally described from Sicily in 1847, but its native distribution is unknown. It occurs pan-globally in warmer regions, probably having been transported by man since early times. *Crocidosema plebiana* was reported from Hawaii by several early authors, but Zimmerman (1978) regards the Hawaiian *Crocidosema* as three distinct, endemic species. Differentiation of Pacific island populations also is discussed by Clarke (1971, 1986). The evidence suggests that *C. plebiana* (sens. lat.) occupied a broad range, and that North American populations probably originated from the Mediterranean. The larvae of *C. plebiana* feed in flowers and fruit of various Malvaceae, including *Hibiscus*, and have been taken on cotton several times in California.

Heinrich (1923) reported *C. plebiana* in the U.S. from California and Texas. In addition, the species has been collected widely in the south, in Louisiana (1916), Florida (1918 onwards) and South Carolina (1944) (USNM; Kimball 1965). The species has long been established and abundant in southern California; the earliest available record is June, 1911 at San Diego, collected by W. S. Wright (USNM). In 1917–1918, it was collected at Chula Vista, San Diego Co. (CAS). By about 1920 it occurred in the San Bernardino area (Barnes collection: USNM), at Riverside by 1932, and on Santa Catalina Island by 1931 (CDFA, LACM). By that time probably it was established throughout much of the Los Angeles basin and Orange Co., where its colonization was documented in the 1940s during the statewide Oriental fruit moth survey by dimalt bait traps (CDFA). Specimens were reared from *Hibiscus* buds at Exposition Park, Los Angeles in 1942 (LACM). The distribution also extended to the coast in the Ventura (1943) and Santa Barbara (1936) areas (CDFA, LACM), and San Luis Obispo Co. (Pismo Beach) by 1959 (EME). *Crocidosema plebiana* was found in the San Joaquin Valley in Kern Co. in 1968 (CDFA).

I had not seen any subsequent records north of a line between Pismo and Bakersfield until *C. plebiana* appeared in Berkeley recently. In late September and October, 1988, two males came to a blacklight, but none was observed in 1989, suggesting that the moths captured in 1988 did not represent an established population. In 1990, however, *C. plebiana* reappeared, with males attracted to blacklight on 9, 12 Jul and on 10 dates between 11 Sep and 17 Oct, confirming the colonization.

PYRALIDAE

Uresiphita reversalis (Guenée)

(Fig. 6)

This large pyraustine, which is known as “the genista caterpillar,” has bright rust-brown forewings and ochreous-yellow hindwings. The moths are primarily nocturnal and come to lights but are easily flushed into activity during the daytime. The larvae are aposematic in color and behavior; they are orange and black spotted, live exposed, without a shelter, and are rendered distasteful by sequestered

alkaloids (Bernays & Montllor 1989). They often occur in defoliating numbers. Hence, populations are easily seen in the field, and this species is not likely to colonize unnoticed for long.

Although its relatives are Old World species, *Uresiphita reversalis* is believed to be a native Nearctic species, having been described originally in 1854 from "North America" without a specified locality. The natural distribution is unknown, but it may have encompassed parts of the southeastern U.S. and Mexico. The present range is reported to be "southern Canada to southern Florida and west to California" (Munroe 1976), but it is likely sustained in northern areas by migrations, not continuously resident populations. In California, moreover, populations are dependent upon introduced plants, particularly *Genista*, grown as ornamentals or in weedy situations, and there are no known records prior to 1930, so *U. reversalis* is assumed to be an introduced or adventive exotic.

In the west there are records as early as 1912 in the Davis Mountains, Texas (LACM) and 1927 in the mountains of southern Arizona (CAS), and there are scattered collections from the Mexican plateau and coastal Sinaloa (EME, UCD), suggesting that native populations may have lived in these areas.

The earliest known record in California is a series collected in Los Angeles in September, 1930, by J. A. Comstock (LACM). By late 1931, *U. reversalis* occurred widely in urban Los Angeles, Orange, San Diego and Ventura counties and had been reared from "Genista and other brooms" at several localities (Keifer 1931). There are records at Riverside and San Bernardino by September, 1932, and Santa Barbara in 1933 (CDFA, CAS, LACM). McKenzie (1933), who described the early stages and recorded hostplants, stated that the initial appearance of this insect in California had been noted only recently.

Populations seemed to stabilize in cismontane southern California during the following 30 years, and there are collection records for nearly every year, indicating that residency was continuous.

The earliest known collection of *U. reversalis* in the San Francisco Bay area is August, 1966, at Stevens Creek [5 km SW of Cupertino], Santa Clara Co., by R. Denno (UCD). This record is puzzling because one would expect this species to have appeared first in an urban area, rather than a forested canyon in the foothills, and because if the collection sampled an established population, it is surprising that no other colonies were detected in the south bay area during the subsequent 13 years. Continuous residency is documented beginning in 1980. Larvae were collected from *Laburnum* in Fremont in July, 1980 (CDFA) and on *Genista* at San Jose at least three times between September, 1980, and September, 1981 (CDFA, EME, SJS), the first by F. Iltis (W. E. Ferguson, personal communication); and the species rapidly colonized northward in the S. F. Bay area during the next 10 years. In 1983, larvae of *U. reversalis* were found in Oakland by P. Neyland (EME), and adults began appearing at localities that R. L. Langston, W. W. Middlekauff or I had been sampling regularly: Antioch, Contra Costa Co. (August), Berkeley (November), San Bruno Mts., San Mateo Co. (December), in Contra Costa Co. at El Cerrito the following year, and Fish Ranch Canyon and Kensington by 1985 (CAS, EME).

Uresiphita reversalis was widely established north of San Francisco Bay by the late 1980s, in Marin (1986) (including Angel Island and Marin Island, 1989), Napa (1988) and Solano (1987) counties (CDFA, EME).

It is likely that *U. reversalis* also spread through the Central Valley and Sierra Nevada foothills during or preceding the 1980s. By 1968, when records were suspended in a card file system at CDFA¹, there were no listings of this pyralid from counties north of the Transverse Ranges; also, there are no voucher specimens for records during the following 11 years. Larvae were collected at Tracy, San Joaquin Co. in late 1982 (SJAC), and at Bakersfield, Kern Co. and near Fresno, Fresno Co. a year later (CDFA, FAC). By 1987, when computerization came on line at CDFA, *U. reversalis* was found in Kern, Tulare, Merced, Placer, and Sacramento counties; by 1988 in Yolo Co. (January) and in the northern Sacramento Valley, in Sutter and Butte (October), and Shasta (1989) counties (CDFA) (Fig. 9). Simultaneously, *Uresiphita* colonized the foothills of the Sierra Nevada in Amador, Nevada, and Tuolumne counties, to elevations of 550–800 m at Sonora and Grass Valley (CDFA).

The genista caterpillar feeds on a variety of legumes, particularly those of the tribe Genisteae (Fabaceae) including *Genista*, *Cytisus*, and *Lupinus*, as well as on *Baptisia* and *Sophora* (Dyar 1901, McKenzie 1933, Kimball 1965, Munroe 1976, Bernays & Montllor 1989). In California, the adventive populations evidently are dependent primarily on *Genista* (= *Cytisus*) *monspessulana* (L.) (French broom) and horticultural hybrids. *Cytisus scoparius* (L.) (Scotch broom) has been recorded as the larval host on several occasions, but at least some of these evidently originate from plant misidentifications or equating the common names “genista,” “broom” and “Scotch broom” as applied to various *Genista* species. For example, there are records from “Scotch broom” in San Diego County in 1931 (CDFA) and 1967 (EME), but *Cytisus scoparius* was not established anyplace south of Monterey County by 1978 (Mountjoy 1979).

There are numerous records of larvae having been collected on nonleguminous plants, including *Buddleia* (Loganiaceae) (McKenzie 1933; CDFA [1964]), asparagus fern (Liliaceae), *Taxus* (Taxaceae), *Gardenia* (Rubiaceae) (CDFA), and “chamise” (SDNH). Such records, along with other evidence (“pupating in doorway,” “barbeque cover,” etc. [CDFA]), probably reflect a propensity of late instar larvae to wander. Particularly when colony densities are high and *Genista* is defoliated, larvae of *U. reversalis* are liable to be found on various other plants in the vicinity.

In the S. F. Bay area, larvae of *U. reversalis* feed on native *Lupinus*, including *L. chamissonis* Eschscholtz when growing in proximity to *Genista monspessulana* (Pt. Molate, JAP 87G4, EME), and on *L. arboreus* Sims according to Bernays & Montllor (1989). In no-choice feeding tests in the laboratory, Bernays and Montllor found that larvae did not feed and soon died when offered certain legumes, including *Medicago*, *Trifolium*, *Vicia*, and *Pickeringia*. They fed successfully on

¹ *Uresiphita reversalis* is rated “C” in pest status by CDFA (a native or established species, against which no agricultural quarantine action may be needed). Most “C” and “D” (beneficial or non-phytophagous non-economic) rated insects ceased to be routinely entered in the CDFA card system in 1968, due to system size restrictions; those rated “Q” [old “X”] (unassessed exotic), “A” (quarantine action mandated) or “B” (county level quarantine), however, continued to be automatically entered in the post-1968 card database. Individual instances of “C” or “D” rated insects also could have been entered, if requested by a CDFA taxonomic specialist for the group; their post-1968 absence on cards does not necessarily mean that no CDFA identification was done. In 1987, the CDFA data system was computerized, and all data from CDFA identifications was once again routinely entered.—(Ed.)

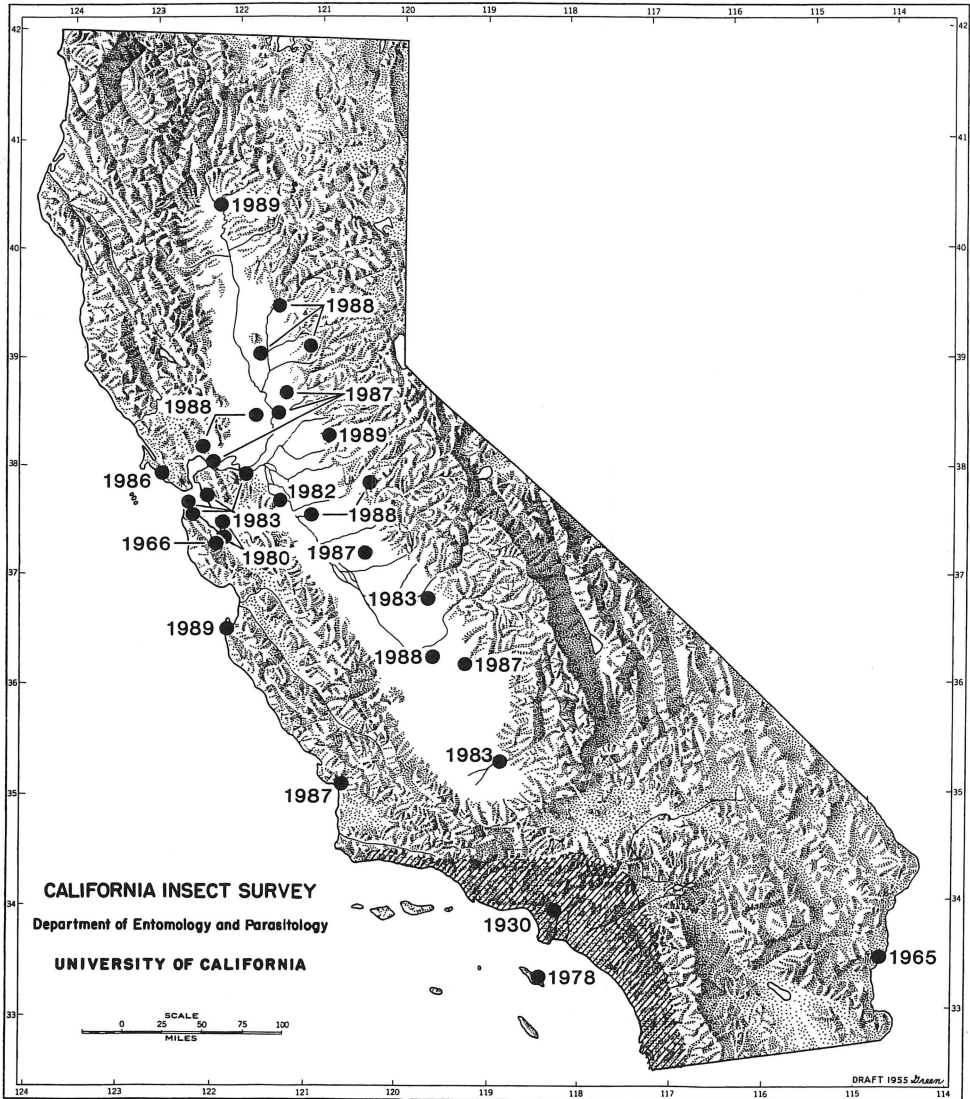


Figure 9. Geographical distribution of *Uresiphita reversalis* in California: by 1931 (shaded area); later dated localities refer to first records in peripheral areas of southern California and first records in counties north of the Transverse Ranges.

Lupinus arboreus, *Cytisus striatus* (Hill), *G. monspessulana*, and *Cytisus scoparius*, and late instar larvae significantly preferred *Lupinus* over *G. monspessulana*, when given the choice.

Bernays & Montllor (1989) believed that the data indicate that the main hosts of *U. reversalis* in California are species of *Lupinus*. However, I have not seen any evidence that populations inhabit less disturbed plant communities where they would be sustained solely by native plants. Moreover, there are no specimen voucher records of larvae on native plants outside of urban situations after more than half a century residency in southern California and none in more northern areas (CAS, CDFA, EME, LACM, SDNH, SJS, UCD). The CDFA has records

of larval collections from "*Lupinus* sp." from Castro Valley, Alameda Co. (1988), Redding, Shasta Co. (1989) and Santa Maria, Santa Barbara Co. (1988) in garden, park, and nursery settings. Some exotic ornamental legumes also serve as hosts, including *Laburnum* at El Cerrito (JAP 84K1) (EME) and *Piptanthus* at the Strybing Arboretum, San Francisco (CAS).

Parapediasia teterrella (Zincken)
(Fig. 7)

Described in 1821 from Georgia, this was one of the first pyralids known in North America. It is widespread in the eastern U.S. and is often extremely abundant at lights in urban areas, such as around Washington, D.C. The original geographical distribution no doubt was modified by human colonization of North America; by the late 1800s it encompassed the Atlantic and midwestern states. Murtfeldt (1893) reported that *P. teterrella* had become more abundant during the past two or three years around Kirkwood, Missouri, than all other crambids combined.

There are records in the southwest as early as half century ago: Tulsa, Oklahoma (1940); Albuquerque, New Mexico (1944); Tucson (1935) and Madera Canyon (1947), Arizona (LACM). Hence, *P. teterrella* may have spread into that region with urbanization during the early 1900s.

The earliest known occurrence in California is August, 1954, at South Gate, Los Angeles Co. (LACM). Records from other parts of southern California and the Central Valley indicate that this lawn moth had colonized in the early 1950s, then spread southward and northward within a few years (Fig. 10). I collected the urban lawn moths, *Crambus sperryellus* Klots and *Tehama bonifatella* (Hulst) and did not find *Parapediasia teterrella* in San Diego during 1953–1956; but in 1957–1959, light trapping by A. A. Lee and R. A. Mackie produced *P. teterrella* at widely separated inland localities: Escondido and Otay, San Diego Co. and at several coastal sites in 1958–1959 (SDNM, EME). The colonization reached Bakersfield, Kern Co., by July, 1959, then quickly spread through the Central Valley, recorded at Madera (1960), Sacramento (1967), and Davis, Yolo Co. (1969) (CDFA). I did not find *P. teterrella* in urban Davis when I sampled there during the summer of 1956.

The adventive populations appear to have extended through the delta region to S. F. Bay, having been recorded at the Antioch National Wildlife Refuge in August, 1981, and at Berkeley beginning in 1988 (EME), when two adults came to blacklight in October. The following season I recorded *P. teterrella* on 16 dates between 19 May and 17 Oct; in 1990 the species became more abundant and seasonally extensive, flying from 9 Apr to 24 Oct (34 dates recorded), often with 5–10 individuals observed. At Berkeley this species has become the most prevalent lawn moth, while *Tehama bonifatella* (Hulst) appears to have declined in numbers (eight and 13 dates in 1989 and 1990, down from 19–29 dates in 1985–1988), although its adult activity was more prolonged than that of *P. teterrella* in 1990 (25 Mar to 12 Nov). The data suggest that competitive displacement is occurring at this site.

Parapediasia teterrella may be better adapted to inland than coastal areas in California, as I have not seen records of its occurrence in urban areas of the coastal counties, from Ventura to San Francisco.

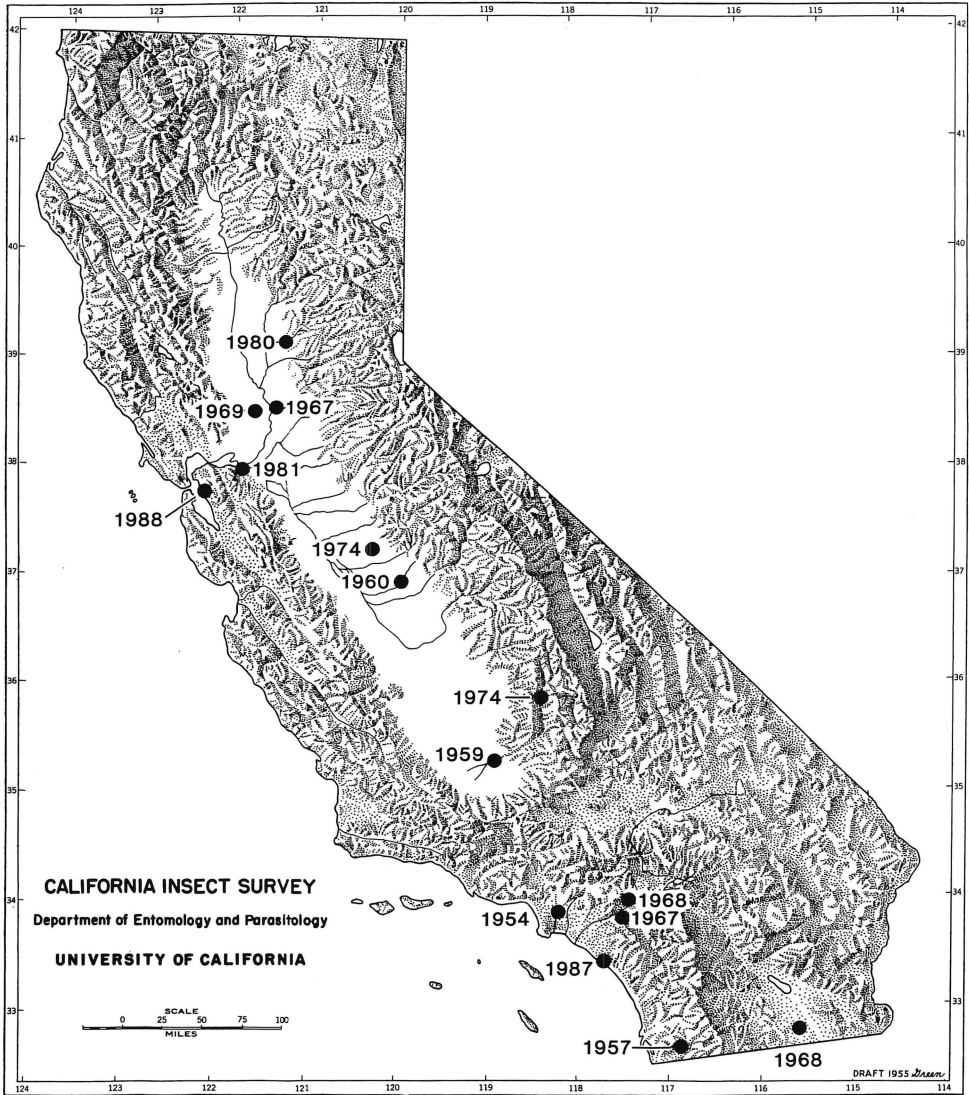


Figure 10. Geographical distribution of *Parapediasia teterrella* in California: dated localities refer to first record in each country.

Achroia grisella (Fabr.)
(Fig. 8)

The lesser wax moth is described in the stored products and general entomological literature as a cosmopolitan insect, but evidently it has not been formally reported in California. *Achroia grisella* is not mentioned by Essig (1926), nor by Keifer during 1927–1954 (Powell 1991); and there were no records from the Pacific states in the USNM in 1977. Larvae of this moth, which is uniformly mouse gray with a contrasting pale yellow head, typically live in old honeycombs but also are said to feed on dried fruit and “apparently” on dried insects (Forbes 1923). The species was originally described from Europe but has been widely established in the Atlantic states at least since the 1890s (USNM).

There are records of *Achroia grisella* in southern California dating back to the early 1900s, but apparently the adults are not readily attracted to lights, and populations likely have been more prevalent and widespread than records indicate. A series was collected by W. S. Wright in San Diego on at least six dates between 1908 and 1915 (SDNH); there are two specimens from the E. Piazza collection, probably from San Diego, taken in 1921, and *A. grisella* was taken at Del Mar, San Diego Co. in 1934–1942 (CDFA, LACM).

Circumstantial evidence suggests that the lesser wax moth colonized central parts of California at a much later date; there are at least 20 collection records from the San Francisco Bay area and Sacramento Valley in the past 40 years but none before that. The earliest vouchered record that I have seen is September, 1952, at Courtland, Sacramento Co. (CDFA); but probably *A. grisella* was widespread in central California by that time, as there are specimens from San Jose, Santa Clara Co. taken in 1955 by J. W. Tilden (SJS) and from Prunedale and Soledad, Monterey Co., in 1956 (CDFA). In the east bay, I took one specimen in 13 years sampling at Walnut Creek, Contra Costa Co. (June, 1964), and adults have been collected sporadically in Berkeley since 1968 (EME). A long series of *A. grisella* was reared by P. A. Rude from larvae in the honeycombs of an abandoned beehive in Kensington in 1978 (EME), but only four individuals, taken on four dates in 1983, 1987 and 1989, have been observed during the past 12 years sampling in Berkeley.

DISCUSSION

Collection records indicate that at least 17 species of exotic Microlepidoptera and pyraloid moths have colonized the San Francisco Bay area during the past half century, including six during the most recent 10 years (Table 1). Five of these evidently were introduced independently from other populations in California, either directly from the Old World (*Batia lunaris*, *Esperia sulphurella*), or from the Pacific northwest or eastern U.S. (*Agonopteryx alstroemeriana*, *Athrips rancidella*, *Cnephasia longana*). The others colonized secondarily from southern California, by local introduction or gradual spread by adventive populations.

Among species that have reached the S. F. Bay area via southern California, several underwent a sequence of introduction-establishment then a long period of naturalization, followed by rapid range extension northward (e.g., Fig. 9) (or colonization via secondary introduction in the bay area). This pattern parallels that shown by other introduced insects, for example the passion vine-feeding butterfly, *Agraulis vanillae* (L.) (Powell 1961), the Old World earwig, *Euborellia annulipes* (Lucas) (Langston & Powell 1975) in California, and the European hesperiid, *Thymelicus lineola* (Ochsenheimer) in midwestern and northeastern U.S. and adjacent Canada (Powell 1983). Such delayed ecogeographical expansions by introduced insects may involve genetic adaptation to environmental situations to which the founder or even source populations were not adapted. The delay cannot always be documented because of incomplete records of adventive populations while they are at low levels, but gaps appear to have been as much as 17 years for *Symmoca signatella*, at least 40 years for *Platynota stultana*, 50 for *Uresiphita reversalis*, and 60 for *Crociosema plebiana*, following widespread establishment in southern California.

By contrast, a few species have colonized in southern California and then apparently began expanding their range without appreciable delay during natu-

ralization. *Parapediasia teterrella* (Fig. 10) colonized the Sacramento Valley within 6–13 years after detection in the Los Angeles basin (but 21 more years passed before establishment in the east bay); *Pyramidobela angelarum* was established in Santa Clara and San Mateo counties eight years after its discovery in Los Angeles (Keifer 1942), and *Opogona omoscopia* reached the bay area within three years of first notice at Santa Barbara, although this may have been via independent introduction, and was widely established after two (San Diego Co.) to nine years (S. F. Bay area).

The data are too fragmentary to document the history of *Oinophila v-flavum* (Powell 1964b) and *Achroia grisella* in California. It would not be surprising to discover that such species have been established in the S. F. Bay area for a half century or more, as was the case for the urban tortricids, *Acleris variegana* (Schiffmüller) (Powell 1964a) in the bay area and *Clepsis unifasciana* (Hübner) in the Pacific northwest (Powell 1988).

Dowell & Gill (1989) compiled a list of 208 invertebrates that they classified as exotic and believed had been discovered in California between 1955 and 1988, based on several USDA and CDFA publications. They include 24 species of Lepidoptera, of which 16 are Microlepidoptera and Pyraloidea. The list is neither complete nor restricted to exotic species. Included are at least four species that likely are native insects:

Bucculatrix tridenticola Braun (erroneously given as Brown), which was originally described in 1963 from southern and eastern Oregon, eastern Washington, Colorado, Utah, and Nevada, occurs in association with *Artemisia tridentata* Nuttall in natural communities in Modoc County, California (several records in 1960s: Hall 1965; EME) and probably throughout the Great Basin. The probable origin inexplicably was given by Dowell and Gill as eastern U.S.

Periploca nigra Hodges was described originally from Sacramento in 1962 and was found to be widely established in the S. F. Bay area on ornamental junipers (Koehler & Tauber 1964). This may be an introduced species, but it is reported to range from New York to Louisiana “then west to Sacramento and San Diego, California” (Hodges 1978). The natural hostplants and geographical distribution in the west are unknown.

Choristoneura conflictana (Walker) is widespread across boreal America in association with *Populus tremuloides* Michaux and was reported from several sites in native aspen forests of the Warner Mountains, Cascades and Sierra Nevada, having been collected in California from 1922–1962 (Powell 1964a).

Eumysia mysiella (Dyar) is a widespread native insect of the Great Basin and southwest. It was described from Stockton, Utah, in 1905 and by the 1960s was recorded in Arizona, New Mexico, and Nevada (Heinrich 1956) (EME). Probably its natural range included California, east of the Sierra Nevada. The larval host is unrecorded, but the closely related *E. idahoensis* Mackie feeds on several species of *Atriplex* (Chenopodiaceae) (Mackie 1958).

Dowell and Gill's list omits several species that were first detected in California between 1955–1988, including *Opogona omoscopia*, discussed above; *Batia lunaris*, which was established on both sides of S. F. Bay by 1962 (Powell 1964c); *Esperia sulphurella*, an early spring, diurnal moth that was discovered at El Cerrito and Berkeley in 1966 and 1967 (Powell 1968) and has been recorded many times during the subsequent two decades (CAS, EME); and *Agonopteryx alstroemeriana*,

which was widely established in the bay area by 1984 (CAS, EME; Powell & Passoa in press) (Table 1).

Combining species validly listed by Dowell and Gill and those for which data are given here, yields a total of at least 27 species of exotic Microlepidoptera and Pyraloidea that have been discovered in California during the half century after 1940. The residency status of several of those included by Dowell and Gill is unknown; populations have been subject to eradication procedures, and/or we lack subsequent collections to confirm colonization and spread (e.g., *Homadaula anisocentra* (Meyrick) and *Endothenia albolineana* (Kearfott)).

ACKNOWLEDGMENT

I thank all the collectors who have made the special efforts needed to acquire study specimens of Microlepidoptera that have enabled us to document the fauna in California during the past 35 years. Particular acknowledgment is due those who sampled in urban areas, including J. P. Donahue (Los Angeles), R. L. Langston (Kensington), R. H. Leuschner (Gardena, Manhattan Beach), C. D. MacNeill (Richmond, El Cerrito), R. A. Mackie (San Diego Co.), W. W. Middlekauff (El Cerrito), D. C. Rentz (San Francisco, Albany), and P. A. Rude (Oakland). Rosemary Leen provided records of *Uresiphita* from her search of 1980–1987 archive files at CDFA, gave me information on the hostplant nomenclature of *U. reversalis*, and offered critical comments on the ms. *Crociosema* data at San Diego Natural History Museum and the U.S. National Museum of Natural History were compiled by J. W. Brown. Records from computer and card files at the California Dept. of Food & Agriculture were provided by T. D. Eichlin and R. Somerby; and K. W. Brown and N. J. Smith provided records from the San Joaquin and Fresno County Agricultural Commissioner's Offices, respectively. Cooperation by the following enabled me to use the collections in their care: V. Lee and N. D. Penny (California Academy of Sciences), J. P. Donahue (Los Angeles County Museum of Natural History), D. K. Faulkner (San Diego Natural History Museum), R. Stecker (San Jose State University, Department of Entomology), the late R. O. Schuster (University of California, Davis, Bohart Entomological Museum), and D. R. Davis and R. W. Hodges (U.S. National Museum of Natural History, Washington, D.C.).

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Received 1 July 1991; accepted 18 August 1991.

REVISION OF THE GENUS *TACHYCOLPURA* BREDDIN (HEMIPTERA: HETEROPTERA: COREIDAE: COLPURINI)

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Abstract.—The genus *Tachycolpura* Breddin (Coreidae: Colpurini) is revised to include *T. luteola* NEW SPECIES, from Borneo, and *T. sumatrana* NEW SPECIES, from Sumatra. *Xenocolpura* Blöte NEW SYNONYM, is synonymized within *Tachycolpura* with the binomial *T. elongata* (Blöte) NEW COMBINATION. The dorsal habitus, pronotum, and female genital plate of each species, and the male genital capsule and parameres of the new species, are illustrated. A key to species is provided.

Key Words.—Insecta, Heteroptera, Coreidae, Colpurini, *Tachycolpura*, NEW SPECIES, Sumatra, Borneo.

The tribe Colpurini contains about 16 genera (*Hygia* with nine subgenera) and 134 species, with several genera and many species awaiting description. Members of the tribe are distributed from Fiji and Australia to India and the eastern Palaearctic region, reaching their greatest diversity in Malaysia, Indonesia and Papua New Guinea (Dolling 1987). The species are usually black or dark colored, with a striking diversity of structure in the male genital capsule and in the female genital plate (Brailovsky 1990).

Breddin (1900) described the genus *Tachycolpura* to include *Lybas penicillatus* Walker, 1871 as the type. Distant (1901) and Bergroth (1913) cited this species only superficially, without adding new morphological or distributional data. Blöte (1936) described and illustrated the new genus and species *Xenocolpura elongata* Blöte, from Sumatra. Within his generic treatment, Blöte does not allude to the affinities that this genus might have with other Colpurini, but only emphasizes, as diagnostic characters, the reduced wings and the conical projections of the humeral angles of the pronotum.

During this revision, we had no doubt in recognizing the close relationship between both genera. In this paper we synonymize *Xenocolpura* with *Tachycolpura*, and create a new binomial, *Tachycolpura elongata*. Two new species, collected in Sumatra and Borneo, are also described.

Tachycolpura is the only genus of Colpurini in which the humeral angles of the pronotum are projected as a conical tooth of variable length, width and trajectory. The tylus, jugae, and the antenniferous tubercles are unarmed and the femora are armed with a double row of spines and granules that decorate their ventral side. The shape of the posterior edge of the genital capsule, the length and width of the gonocoxae I and of paratergite IX, the development of the wings, and the color of the hemelytral membrane, the corium and the tibiae, all characterize the genus.

The following abbreviations identify the institutions where types are deposited, and specimens were loaned: Bernice P. Bishop Museum, Honolulu, Hawaii (BPBM); The Natural History Museum, London (BMNH); Colección Entomológica del

Instituto de Biología, Universidad Nacional Autónoma de México (IBUNAM); Museum d'Histoire Naturelle, Geneva, Switzerland (MGHN); Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands (RNHL); Zoologisches Museum, Universiteit Van Amsterdam, Netherlands (ZMUA).

TACHYCOLPURA BREDDIN

Tachycolpura Breddin, 1900. Rev. d'Entomol. 19: 215.

Tachycolpura: Bergroth, 1913. Mem. Soc. Entomol. Belg. 22: 142.

Xenocolpura Blöte, 1936. Zool. Meded. 19: 44, NEW SYNONYM.

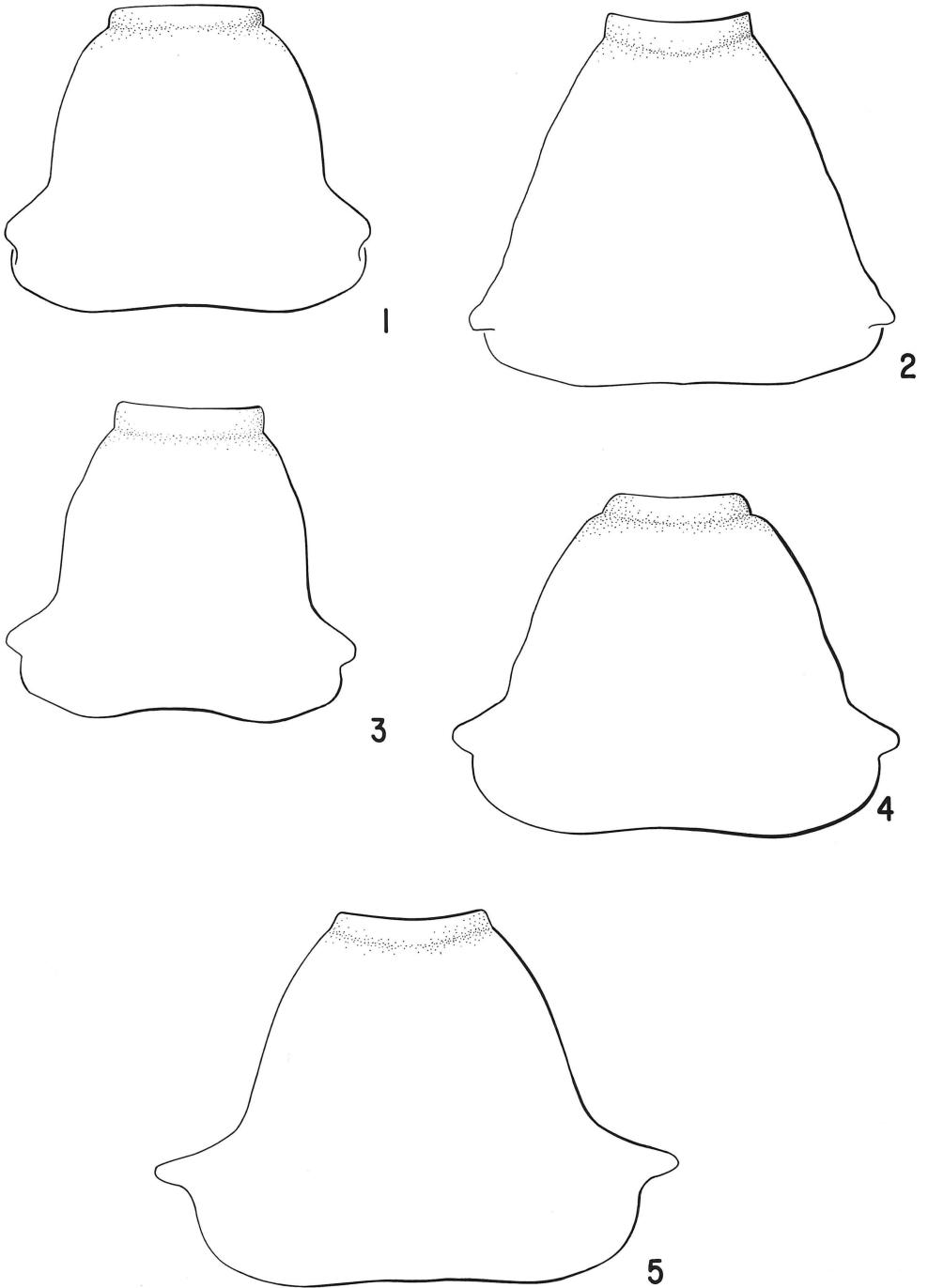
Type Species.—*Lybas penicillatus* Walker.

Redescription.—Narrow body, moderately elongated, with an average length from 16.48 mm to 20.15 mm. *Head.* Longer than wide, elongate, cylindrical and slightly narrowed basally; tylus unarmed, apically truncate, extending anterior to jugae, and seen laterally extending above them; antenniferous tubercles unarmed with truncate apex; jugae unarmed; antennal segment I robust, cylindrical, slightly curved outwards and longer than head; segment II longest, segment IV shortest and fusiform; segments II and III cylindrical; ocelli not elevated; preocellar pit deep, diagonally excavated; eyes spherical; tubercles postocular protuberant; side of head in front of eyes straight, slightly convergent; bucculae rounded, short, not projecting beyond antenniferous tubercle, with sharp mesial projection and anterior edges thickened; rostrum long, reaching the medial one-third of abdominal sternite V, or almost to apex of VII; rostral segment IV longest, III longer than II and II longer than I, which is shortest. *Thorax.* *Pronotum.* Wider than long, moderately sloped; anterior collar wide; anterolateral edges ranging from oblique and gently rounded to almost straight; humeral angles projected into conical tooth, directed upwards and slightly backwards, with variable length (Figs. 1–5); posterior edge straight. Anterior lobe of metathoracic scent gland globose and reniform, posterior lobe sharp, small. *Legs.* Femora with two rows of granules and small spines along ventral surface, less abundant on metafemur; tibiae with shallow sulcus, sometimes difficult to see; metatibiae longer than metafemur. *Scutellum.* Triangular, longer than wide, with sharp apex. *Hemelytra.* Macropterous, reaching median one-third of abdominal segment VII of male or median one-third of VIII, or anterior one-third of IX in female, or coleopteroid and extending to anterior third of abdominal segment V in both sexes (see Slater 1975); claval suture evident or barely so (coleopteroid individuals); claval commissure shorter than total length of scutellum; apical border obliquely straight, with short apical angle not reaching middle one-third of hemelytral membrane; hemelytral membrane with few bifurcate veins. *Abdomen.* Connexival segments higher than body, forming a case where hemelytra rest; posterior angle of connexival complete, or extended into a very short, wide projection; abdominal sternites with medial sternal furrow projecting to posterior border of sternites V or VI. *Integument.* Body surface rather dull. Head, pronotum, scutellum, clavus, corium, thorax, abdominal sterna and exposed parts of genital segments of both sexes strongly punctate. Antennae and legs minutely granulate. Head, pronotum, scutellum, clavus, corium, thorax and abdominal sterna with long, decumbent to suberect conspicuous golden or silvery bristle-like hairs. Pronotum, thorax and abdominal sterna with circular gray-white farinose punctures.

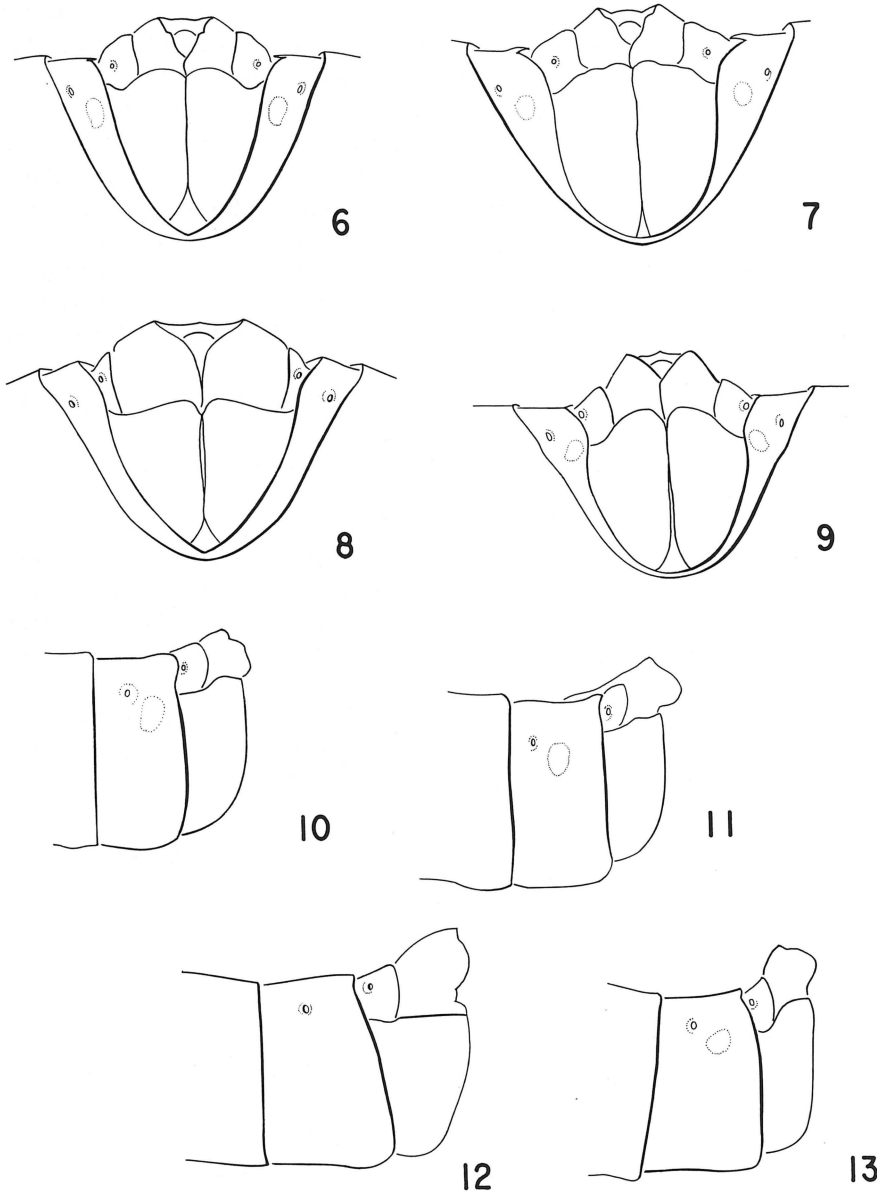
Male Genitalia.—*Genital Capsule.* Posteroventral edge bidentate (Figs. 14–16). *Parameres.* Simple and straight body; apical projection widened, with the anterior lobe convex or continuous with body and the posterior lobe ending in a sharp and short projection (Figs. 20–24).

Female Genitalia.—Abdominal sternite VII with plica and fissure evident; plica narrow or elevated and transversely evolved; gonocoxae I nearly square, large; paratergite VIII short, square, with spiracle visible; paratergite IX nearly square, larger than former paratergite VIII (Figs. 6–13). *Spermatheca.* Bulb long and dilated, duct coiled, with short membranous duct (Fig. 25).

Diagnosis.—*Tachycolpura* is the only genus within the Colpurini that has the humeral angles of the pronotum projected into a sharp and robust conical projection, of variable length and trajectory. Other typical characters are an unarmed tylus, jugae and antenniferous tubercles, an armed femora of all three pairs of



Figures 1-5. Pronotum view of *Tachycolpura* spp. Figures 1, 2. *T. penicillata* (Walker). Figure 1. Male. Figure 2. Female. Figure 3. *T. elongata* (Blöte) NEW COMBINATION. Figure 4. *T. luteola*, NEW SPECIES. Figure 5. *T. sumatrana* NEW SPECIES.



Figures 6–9. Frontal view of the female genital plates of *Tachycolpura* spp. Figure 6. *T. penicillata* (Walker). Figure 7. *T. elongata* (Blöte) NEW COMBINATION. Figure 8. *T. luteola* NEW SPECIES. Figure 9. *T. sumatrana* NEW SPECIES. Figures 10–13. Lateral view of female genital plates of *Tachycolpura* spp. Figure 10. *T. penicillata* (Walker). Figure 11. *T. elongata* Blöte NEW COMBINATION. Figure 12. *T. luteola* NEW SPECIES. Figure 13. *T. sumatrana* NEW SPECIES.

legs, and a notoriously elongated head. The presence of a fissure and a plica in the female, together with the spiny projection of the buccula, confirm the generic diagnosis of the genus.

Discussion.—Wing development in the Colpurini is notoriously variable, in-

cluding apterous, coleopteroid, micropterous, submacropterous and macropterous species, even within a genus (*Sciophyrus*) and a species (*Brachylybas* spp.). Therefore, wing character is not a reliable tool for a generic definition.

Blöte (1936) in describing and illustrating *Xenocolpura*, noted that its characteristic features are especially a brachypterous condition, the presence of a subconical tooth in the humeral angles of the pronotum and a thorny projection in the bucua. In examining the type material of *X. elongata* Blöte and *Tachycolpura penicillata* (Walker), both monotypic genera, we could not find any definitive characters to be used. Both species have the same degree of development of the humeral angles, the bucua and of the genital plates of the female. Therefore, we synonymized *Xenocolpura* within *Tachycolpura*, and included *X. elongata* as the second known species of *Tachycolpura*.

Distribution.—Four species are known from Malaya, Sumatra, Singapore and Borneo.

Biology.—Apparently a very scarce genus restricted to forested areas.

Key to *Tachycolpura* Species

1. Coleopteroid individuals, with the hemelytral membrane not extending beyond abdominal segment V; claval suture not evident; gonocoxae I long, with a maximum length of 3.00 mm (Figs. 7, 11); posterior border of genital capsule with two short projections, with robust and truncated apices (Figs. 16, 19) (Sumatra)
..... *T. elongata* (Blöte) NEW COMBINATION
- 1'. Macropterous individuals, with the hemelytral membrane reaching abdominal segment VII of male, or IX in female; claval suture evident; gonocoxae I shorter than 2.90 mm 2
- 2(1'). Apical angle and apical margin of corium yellow; genital capsule elongate, with posterior margin oblique and convergent, with two short projections with rounded apices (Figs. 15, 18) (Borneo)
..... *T. luteola* NEW SPECIES
- 2'. Apical angle and apical border of corium black or brown-red; genital capsule globose, with the posterior edge widened, with two short rounded lobes (Figs. 14, 17) 3
- 3(2'). Humeral angle of pronotum with long, thin, slender conical projections (Fig. 5); clavus and corium pallid red-orange; tibiae dark orange, with two yellow rings, one subbasal and the other almost apical (Sumatra)
..... *T. sumatrana* NEW SPECIES
- 3'. Humeral angles of pronotum with short and robust projections (Figs. 1-2); clavus and corium black; tibiae dark red-brown, without yellow rings (Singapore, Borneo) *T. penicillata* (Walker)

Tachycolpura penicillata (Dallas)
(Figs. 1, 2, 6, 10, 14, 17, 20, 21, 26)

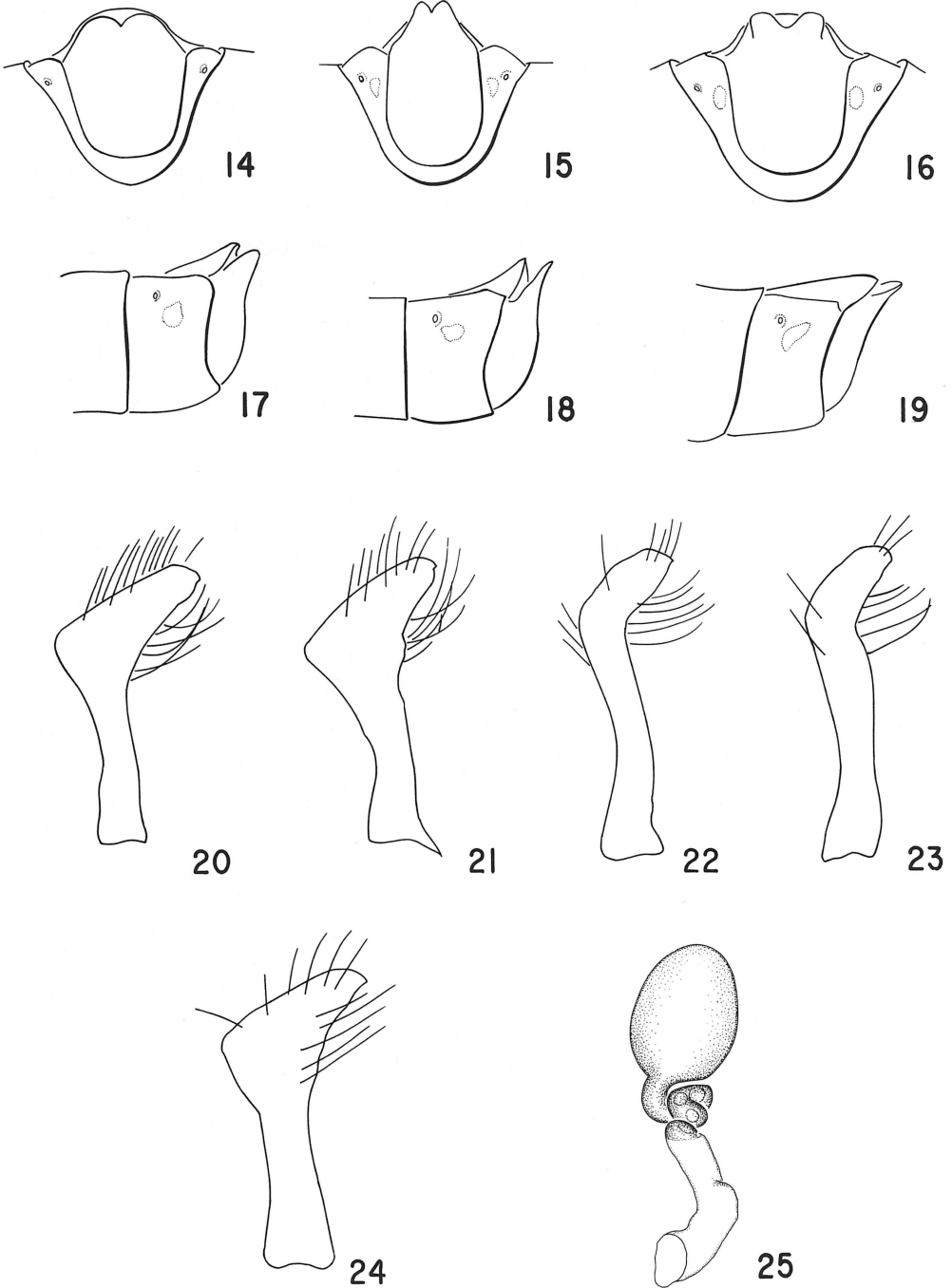
Lybas penicillatus Walker, 1871. Cat. Hem. IV: 150-151.

Lybas penicillatus: Lethierry & Severin, 1894. Cat. Gen. 2: 42.

Tachycolpura penicillata: Breddin, 1900. Rev. d'Entomol. 19: 216.

Colpura penicillatus: Distant, 1901. Ann. Mag. Nat. Hist. Ser. 7(7): 20.

Tachycolpura penicillata: Bergroth, 1913. Mem. Soc. Entomol. Belg. 22: 142.



Figures 14–16. Frontal view of the male genital capsule of *Tachycolpura* spp. Figure 14. *T. penicillata* (Walker). Figure 15. *T. luteola* NEW SPECIES. Figure 16. *T. elongata* (Blöte) NEW COMBINATION. Figures 17–19. Lateral view of the male genital capsule of *Tachycolpura* spp. Figure 17. *T. penicillata* (Walker). Figure 18. *T. luteola* NEW SPECIES. Figure 19. *T. elongata* (Blöte) NEW COMBINATION. Figures 20–24. Parameres of *Tachycolpura* spp. Figures 20, 21. *T. penicillata* (Walker) Figures 22, 23. *T. luteola* NEW SPECIES. Figure 24. *T. elongata* (Blöte) NEW COMBINATION. Figure 25. Spermatheca of *Tachycolpura luteola* NEW SPECIES.

Types.—*Lybas penicillatus* Walker. We designate a female, collected in Singapore and deposited in the Natural History Museum, London, as a Lectotype.

Redescription.—*Female. Color.* Black with the following areas pale ochre or pale orange: upper side of the postocular tubercles, apex of scutellum, a very small discoidal dot on middle one-third of apical margin of corium, posterior one-third of connexivum, anterior and posterior lobes of metathoracic scent gland, and posterior angle or pleural margin of abdominal sternites III to VII; antennal segments II and III, rostral segments I to IV and tibiae and tarsi dark red-brown; antennal segment I black, and IV dark ochre, with basal one-third red; hemelytral membrane dirty yellow with veins red-brown, basal angle and anterior margin pale yellow. *Structures.* Rostrum reaching posterior border of sternal segment V; humeral angles of pronotum projecting into a conical, short, robust tooth, pointed backward (Fig. 2); hemelytra macropterous, with claval suture evident and membrane reaching middle one-third of abdominal segment VIII; posterior angle of connexival segments V and VI not projecting out from surface; gonocoxae I conspicuously long, with the maximum width large; paratergite IX nearly square, short and barely reaching beyond the external border of gonocoxae I (Figs. 6, 10). *Measurements:* Head length: 2.85 mm; interocellar space: 0.64 mm; interocular space: 1.44 mm; width across eyes: 2.15 mm; preocular distance: 1.85 mm; length antennal segments: I, 4.00 mm; II, 5.20 mm; III, 3.70 mm; IV, 2.25 mm. Pronotal length: 3.70 mm; width across frontal angles: 1.70 mm; width across humeral angles: 4.90 mm. Scutellar length: 2.35 mm; width: 2.00 mm. Maximum length of gonocoxae I seen frontally: 2.85 mm; maximum length of gonocoxae I seen laterally: 1.35 mm. Total body length: 17.65 mm.

Male.—*Color.* Similar to female, but hemelytral membrane dirty yellow with veins and anterior margin brown and only basal angle yellow. *Structures.* Humeral angles produced into a short conical tooth, barely projecting beyond posterolateral edge of pronotum (Fig. 1). Macropterous hemelytra and membrane reaching middle one-third of abdominal segment VII. Genital capsule globose with posterior margin widened and with two short rounded mounds (Figs. 14, 17). *Parameres.* Figs. 20–21. *Measurements:* Head length: 2.84 mm; interocellar space: 0.64 mm; interocular space: 1.25 mm; width across eyes: 2.13 mm; preocular distance: 1.68 mm; length antennal segments: I, 4.00 mm; II, 5.16 mm; III, 3.70 mm; IV, 2.23 mm. Pronotal length: 3.30 mm; width across frontal angles: 1.70 mm; width across humeral angles: 3.92 mm. Scutellar length: 2.20 mm; width: 1.65 mm. Total body length: 16.48 mm.

Diagnosis.—Macropterous species, characterized by having the humeral angles of the pronotum projected into a short, conical robust tooth (Fig. 1), or very small (Fig. 2), and in each condition pointed backward, with the middle one-third of the apical margin of corium with a discoidal small yellow patch. The male genital capsule is globose, with the posterior margin widened and apices produced into two rounded mounds (Figs. 14, 17). Paratergite IX of female square, short, and barely surpasses the external border of gonocoxae I (Figs. 6, 10). The basal angle of the hemelytral membrane yellow.

Distribution.—Originally described from Singapore and northern Borneo (Sarawak).

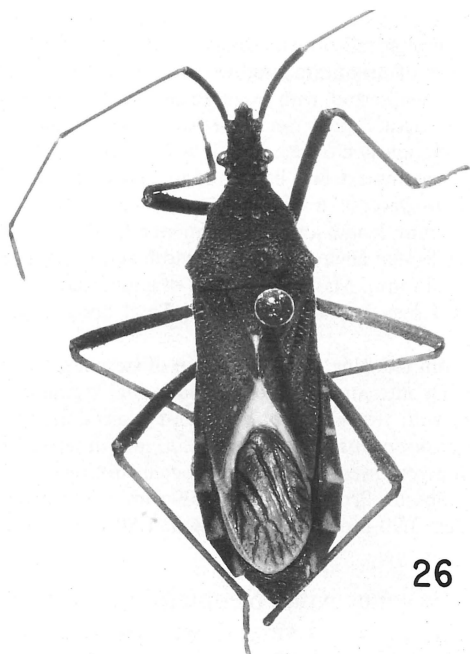
Material Examined.—One male and three females, among them the female lectotype. *Data:* MALAYA. Ulu Gombok. INDONESIA. BORNEO: Without localities.

Tachycolpura elongata (Blöte) NEW COMBINATION
(Figs. 3, 7, 11, 16, 19, 24, 29)

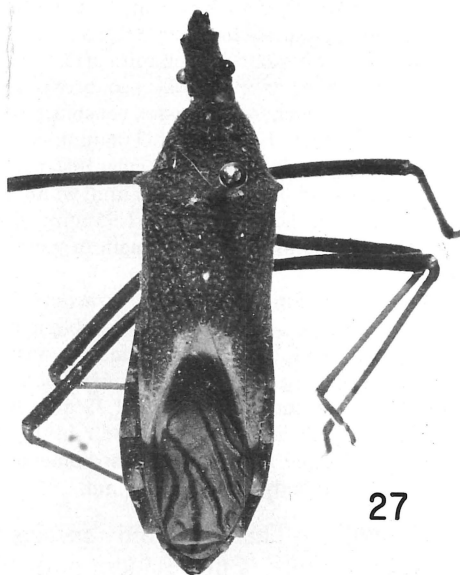
Xenocolpura elongata Blöte, 1936. Zool. Meded. 19: 44–45.

Types.—Female holotype deposited in the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.

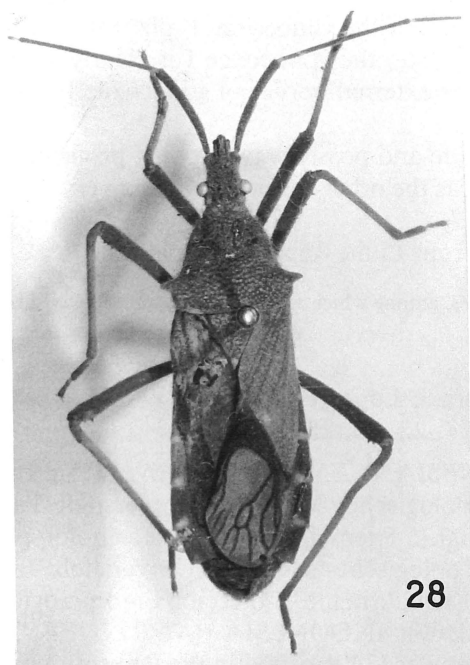
Redescription.—*Female. Color.* Black, with following areas orange ochre: dorsum of postocular tubercles, apex of scutellum, posterior margin of connexivum, and anterior and posterior lobes of



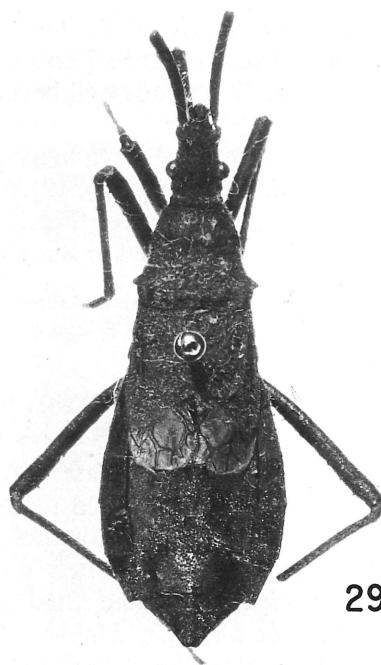
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Figures 26–29. Dorsal view *Tachycolpura* spp. Figure 26. *T. penicillata* (Walker). Figure 27. *T. luteola* NEW SPECIES. Figure 28. *T. sumatrana* NEW SPECIES. Figure 29. *T. elongata* (Blöte) NEW COMBINATION.

metathoracic scent glands; rostral segments I to IV, trochanters, most of tibiae and tarsi red-brown; hemelytral membrane dirty yellow, with veins and basal angle red-brown. *Structures*. Rostrum reaching posterior border of sternal segment V; humeral angles of pronotum produced into a robust, short, conical tooth, projected backward (Fig. 3); hemelytra coleopteroid, with claval suture not evident, and membrane reaching anterior one-third of abdominal segment V; posterior angle of connexival segments V–VI well marked against surface; gonocoxae I conspicuously elongated, with well developed maximum width; paratergite IX square, conspicuously surpassing external border of gonocoxae I (Figs. 7, 11). *Measurements*: Head length: 3.06 mm; interocellar space: 0.76 mm; interocular space: 1.40 mm; width across eyes: 2.35 mm; preocular distance: 2.12 mm; length antennal segments: I, 3.90 mm; II to IV absent. Pronotal length: 3.48 mm; width across frontal angles: 1.74 mm; width across humeral angles: 4.55 mm. Scutellar length: 1.95 mm; width: 1.85 mm. Maximum length of gonocoxae I seen frontally: 3.00 mm; maximum length of gonocoxae I seen laterally: 1.80 mm. Total body length: 18.25 mm.

Male.—*Color*. Similar to female. *Structures*. Rostrum reaching anterior margin of sternal segment VII; coleopteroid, with hemelytral membrane reaching anterior one-third of abdominal segment V. Genital capsule globose, posterior margin widened, with two short robust lateral projections with truncate apices (Figs. 16, 19). *Parameres*. Fig. 24. *Measurements*: Head length: 3.00 mm; interocellar space: 0.67 mm; interocular space: 1.38 mm; width across eyes: 2.30 mm; preocular distance: 2.00 mm; length antennal segments: I, 3.83 mm; II to IV absent. Pronotal length: 3.09 mm; width across frontal angles: 1.69 mm; width across humeral angles: 3.90 mm. Scutellar length: 1.80 mm; width: 1.55 mm. Total body length: 17.18 mm.

Diagnosis.—This is the only species in the genus with coleopteroid hemelytra; the claval suture is not evident and the membrane is very short, not extending beyond the anterior one-third of abdominal segment V. The aspect of the humeral angles of the pronotum, as well as the length of the gonocoxae I, place it near *T. penicillata* (Walker), but in *T. elongata* (Blöte) the gonocoxae I is clearly wider and paratergite IX extends well beyond the external border of gonocoxae I (Figs. 6, 7, 10, 11).

The genital capsule of *T. elongata* is wide and possesses two robust projections with truncated apices (Figs. 16, 19), whereas the other species have two very short mounds with rounded apices (Figs. 14, 17).

Distribution.—Restricted to Sumatra, from Lubu Raja and Tapanuli.

Material Examined.—One male and three females, among which was the holotype. INDONESIA. (WEST) SUMATRA: PADANG: Pandjang.

Tachycolpura luteola Brailovsky, Barrera & Lopez-Forment NEW SPECIES
(Figs. 4, 8, 12, 15, 18, 22, 23, 25, 27)

Types.—Holotype: male; data: INDONESIA. (CENTRAL) BORNEO: Sg. Pajau, 1925, Mjoberg. Deposited in the Zoologisches Museum, Universiteit Van Amsterdam, Netherlands. Paratypes: 3 males, 5 females; same data as holotype. (2 males and 4 females deposited in the Zoologisches Museum, Universiteit Van Amsterdam, Netherlands and 1 male and 1 female in the “Colección Entomológica del Instituto de Biología, UNAM, México”); INDONESIA. (NORTHWEST) BORNEO: Kuching, Jan 1900, Dyak, 4 females (3 deposited in the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands and 1 in the “Colección Entomológica del Instituto de Biología, UNAM, México”).

Description.—*Male (holotype)*. *Color*. Black, with the following areas ochre or yellow ochre, sometimes with orange reflections: apex of scutellum, apical angle and apical margin of corium, posterior margin of connexivum, internal side of trochanters, anterior and posterior lobes of metathoracic scent glands, and angle or posterior margin of pleural margin of abdominal sternites IV to VII; antennal

segments II, III and tibiae dark red-brown; rostral segments I to IV and tarsi lighter red-brown; antennal segment I black, IV yellow with basal one-third brown; external side of trochanters shiny red-brown; hemelytral membrane dirty yellow with veins and subbasal large brown blotch and pallid yellow basal angle. *Structures*. Rostrum reaching anterior border of sternal segment VI; pronotal humeral angles projecting into a short, robust, conical tooth pointed outwards and slightly downwards (Fig. 4); macropterous hemelytra, claval suture evident, membrane reaching middle one-third of abdominal segment VII; posterior angle of connexival segments V and VI not marked on surface. Genital capsule long, posterior margin becoming narrower with conspicuous oblique border, and two short lateral projections with rounded apices (Figs. 15, 18). *Parameres*. Figs. 22, 23. *Measurements*: Head length: 3.00 mm; interocellar space: 0.72 mm; interocular space: 1.26 mm; width across eyes: 2.15 mm; preocular distance: 1.95 mm; length antennal segments: I, 4.75 mm; II, 6.70 mm; III, 4.65 mm; IV, 2.70 mm. Pronotal length: 3.45 mm; width across frontal angles: 1.62 mm; width across humeral angles: 4.10 mm. Scutellar length: 2.25 mm; width: 1.90 mm. Total body length: 17.80 mm.

Female.—*Color*. Similar to male. *Structures*. Macropterous, with hemelytral membrane reaching posterior margin of abdominal segment IX. Gonocoxae I short lengthwise with well developed width; paratergite IX square, reaching beyond external margin of gonocoxae I (Figs. 8, 12). *Spermatheca*. Fig. 25. *Measurements*: Head length: 2.85 mm; interocellar space: 0.70 mm; interocular space: 1.17 mm; width across eyes: 2.10 mm; preocular distance: 1.90 mm; length antennal segments: I, 4.15 mm; II, 5.70 mm; III, 4.05 mm; IV, 2.40 mm. Pronotal length: 3.60 mm; width across frontal angles: 1.65 mm; width across humeral angles: 4.85 mm. Scutellar length: 2.20 mm; width: 1.95 mm. Maximum length of gonocoxae I, seen frontally: 2.25 mm; maximum length of gonocoxae I, seen laterally: 1.55 mm. Total body length: 17.90 mm.

Diagnosis.—This distinctive species is recognized by the light yellow color of the apical angle and apical margin of the corium. In *T. penicillata* and *T. elongata*, the corium are entirely black. The length of the gonocoxae I is very short (2.25 mm) and the posterior margin of the genital capsule is narrowed apically, with conspicuously oblique margins and two short rounded apical projections (Figs. 15, 18). In the other species, the gonocoxae I is longer (2.80–3.00 mm), and the genital capsule is wider and globose, with both projections truncated apically (Figs. 16, 19), or rounded (Figs. 14, 17).

Etymology.—The taxon name is based on the yellow color of the apical angle and the apical margin of the corium.

Material Examined.—See types.

Tachycolpura sumatrana, Brailovsky, Barrera & Lopez-Forment
NEW SPECIES

Type.—Holotype: female; data: INDONESIA. SUMATRA: Deli (Bed Pict), without date. Deposited in the Museum d'Histoire Naturelle, Geneva, Switzerland. The left wing of the holotype is destroyed.

Description.—*Female (holotype)*. *Color*. Head, pronotum, scutellum, thorax and abdominal sternites black with pale red reflections at apex of tylus, scutellar disc, acetabula of three pairs of legs, abdominal sternites, genital plates and pleural margin of abdominal sternites III to VII; ochre yellow on: upper side of postocular tubercles, apex of scutellum, semi-discoidal spot on middle one-third of apical margin of corium, posterior margin of connexival, anterior and posterior lobes of metathoracic scent gland, and posterior margin of pleural margin of abdominal sternites III to VII; antennal segment I dark red-brown, segments II and III pale red-orange, IV yellow with basal one-third pale orange; clavus, corium, connexivum and dorsal segments of abdomen red-orange; hemelytral membrane dirty yellow with veins and large subbasal brown spot and basal angle dark ochre; coxae and femora red-brown; trochanters bicolored, with external side red-brown, and internal side yellow; tibiae dark orange with two yellow rings, one subbasal, other almost apical; orange tarsi with ochre reflections; rostral segments I to IV brown ochre. *Structures*. Rostrum reaching posterior border of sternal segment V; humeral angles of pronotum produced into long, thin, slightly backwards inflected conical prominence

(Fig. 5); macropterous hemelytra with claval suture evident and membrane reaching middle one-third of abdominal segment IX; posterior angle of connexival segments V and VI slightly remarked on surface; gonocoxae I well developed longitudinally and transversely widened; paratergite IX square, length exceeding posterior margin of gonocoxae I (Figs. 9, 13). *Measurements*: Head length: 3.05 mm; interocellar space: 0.65 mm; interocular space: 1.30 mm; width across eyes: 2.30 mm; preocular distance: 1.90 mm; length antennal segments: I, 4.10 mm; II, 5.65 mm; III, 3.80 mm; IV, 2.25 mm. Pronotal length: 3.60 mm; width across frontal angles: 1.80 mm; width across humeral angles: 5.85 mm. Scutellar length: 2.45 mm; width: 2.15 mm. Maximum length of gonocoxae I, seen frontally: 3.00 mm; maximum width of gonocoxae I, seen laterally: 1.60 mm. Total body length: 17.30 mm.

Male.—Unknown.

Diagnosis.—The peculiar long and slender (Fig. 5) projections of the humeral angles of the pronotum, the pale red-orange coloration of the clavus, corium, connexivum and the abdominal segments, and the two yellow rings on the tibiae, are diagnostic characters of *T. sumatrana*. All the other species have shorter and more robust conical projections of the humeral angles; their clavus, corium, connexivum and abdominal segments are black, and their tibiae lack two yellow rings.

Etymology.—Named for its occurrence on the Island of Sumatra.

Material Examined.—See types.

ACKNOWLEDGMENT

We are indebted to the following individuals and institutions for the loan of specimens and other assistance: Gordon M. Nishida (Bernice P. Bishop Museum, Honolulu); J. Palmer and Janet Margerison Knight (British Museum [Natural History], London); Jan Van Tol (Rijksmuseum van Natuurlijke Histoire, Leiden); W. Hogenes (Zoologisch Museum, Universiteit Van Amsterdam); B. Hauser (Museum d'Histoire Naturelle, Geneva).

Special thanks are extended to the Dirección General de Asuntos del Personal Académico of the Universidad Nacional Autónoma de México (DGAPA) and to the Consejo Nacional de Ciencia y Tecnología (CONACyT) for financial assistance to the senior author.

We thank the reviewers for reading and comments.

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Received 1 July 1991; accepted 18 October 1991.

**DESCRIPTIONS OF IMMATURES OF *EOEURYSA*
FLAVOCAPITATA MUIR FROM TAIWAN
(HOMOPTERA: DELPHACIDAE)**

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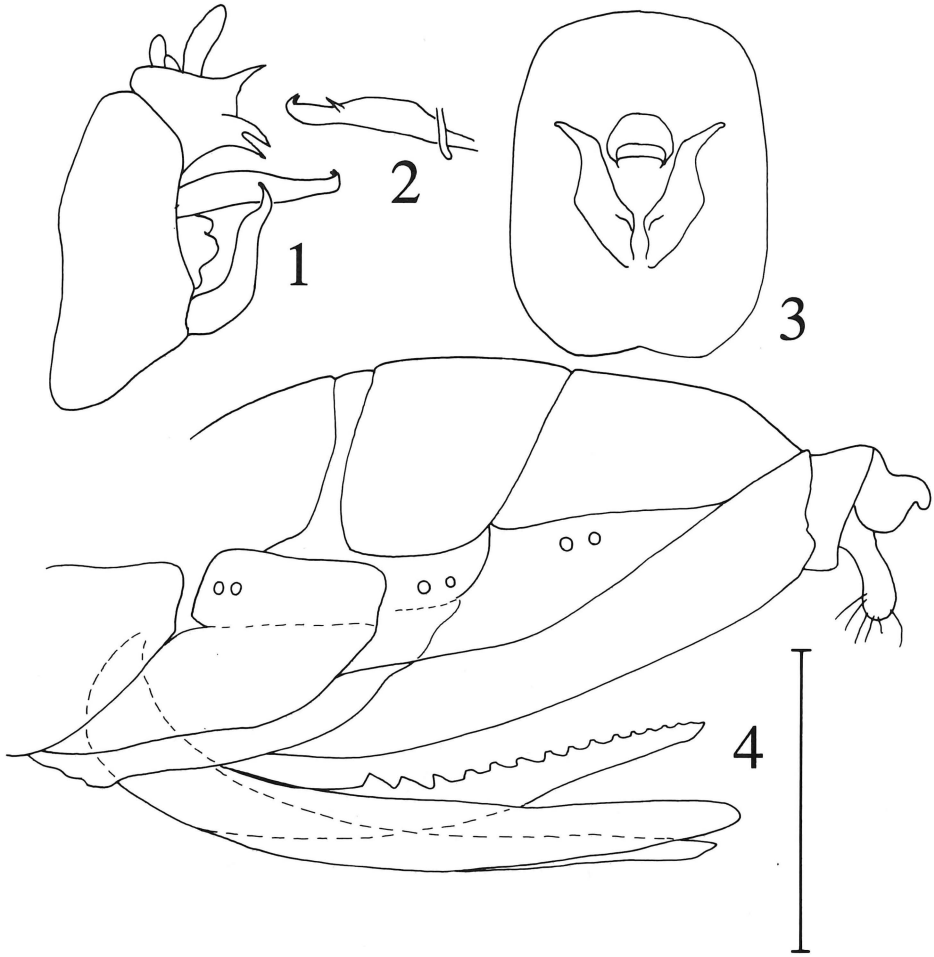
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Abstract.—Adult male and female genitalia, the egg, and first through fifth instar nymphs of the delphacid planthopper *Eoeyrysa flavocapitata* Muir, collected from sugarcane (*Saccharum officinarum* L.) from Taiwan are described and illustrated and a key to instars is provided. Features useful in separating nymphal instars include differences in body size and proportions; spination of metatibiae, metatibial spurs, and metatarsomeres; and number of metatarsomeres.

Key Words.—Insecta, Homoptera, Delphacidae, *Eoeyrysa flavocapitata*, immature stages, Taiwan, sugarcane

The delphacid planthopper *Eoeyrysa flavocapitata* Muir has been recorded from northeastern India, Bangladesh, Malaysia, China, Indonesia, and Taiwan (Chatterjee 1971, Chatterjee & Choudhuri 1979, Chu & Chiang 1975, Metcalf 1943, Mirza & Qadri 1964, Qadri 1963). Adult females insert eggs in, and adults and nymphs feed on, leaves of sugarcane (*Saccharum officinarum* L.). Feeding causes leaf desiccation, development of red streaks on damaged tissue, and growth of sooty mold on the honeydew produced by the planthopper (Chatterjee & Choudhuri 1979, Fennah 1969). Sugarcane is the only recorded host, and *E. flavocapitata* may be monophagous on this grass as are over 20 species of sugarcane delphacids in the genus *Perkinsiella* (Wilson 1988). However, the Neotropical sugarcane pest *Saccharosydne saccharivora* (Westwood) was found to have two species of *Andropogon* as its natural hosts (Metcalf 1969) and apparently included the related grass sugarcane (all in the tribe Andropogoneae [Clayton and Renvoize 1986]) in its range of food plants after introduction of sugarcane to the New World. The only other *Eoeyrysa*, *E. arundina* Kuoh and Ding, has been found only on *Arundo donax* L. (Yang 1989), another economically important grass, which is not closely related to sugarcane (Clayton & Renvoize 1986).

The biology of *E. flavocapitata* on sugarcane was studied by Chatterjee & Choudhuri (1979) and Jiang (1976) who provided information on oviposition, feeding sites, and duration of stadia. Adults were described and illustrated by Chu & Chiang (1975), Jiang (1976) and Yang (1989). Brief descriptions of immatures were provided by Chatterjee & Choudhuri (1979), who also included somewhat diagrammatic illustrations, and Jiang (1976 [in Chinese]); the fifth instar was described, and partial illustrations provided, by Wu & Yang (1985). The present paper includes detailed descriptions and illustrations of adult male and female genitalia, and the immature stages; it also gives a key for the separation of nymphal instars.



Figures 1–4. *Eoerysa flavocapitata* adult genitalia. Figure 1. Male, left lateral view of complete genitalia. Figure 2. Male, right lateral view of aedeagus. Figure 3. Male, caudal view of pygofer and styles. Figure 4. Female, lateral view of complete genitalia. Scale bar = 0.5 mm.

METHODS

Terminology used in the description of the female genitalia follows Asche (1985) and Heady & Wilson (1990). The fifth instar is described in detail but only major differences are described for fourth through first instars. Arrangement and number of pits is provided for the fifth and fourth instars; this information is not given for earlier instars because the pits are extremely difficult to discern (those that could be observed relatively easily are illustrated). Measurements are given as mean \pm SD. Length was measured from apex of vertex to apex of abdomen, width across the widest part of the body, and thoracic length along the midline from the anterior margin of the pronotum to the posterior margin of the metanotum. Eggs were obtained by excising them with a fine needle from sections of field collected sugarcane leaves.

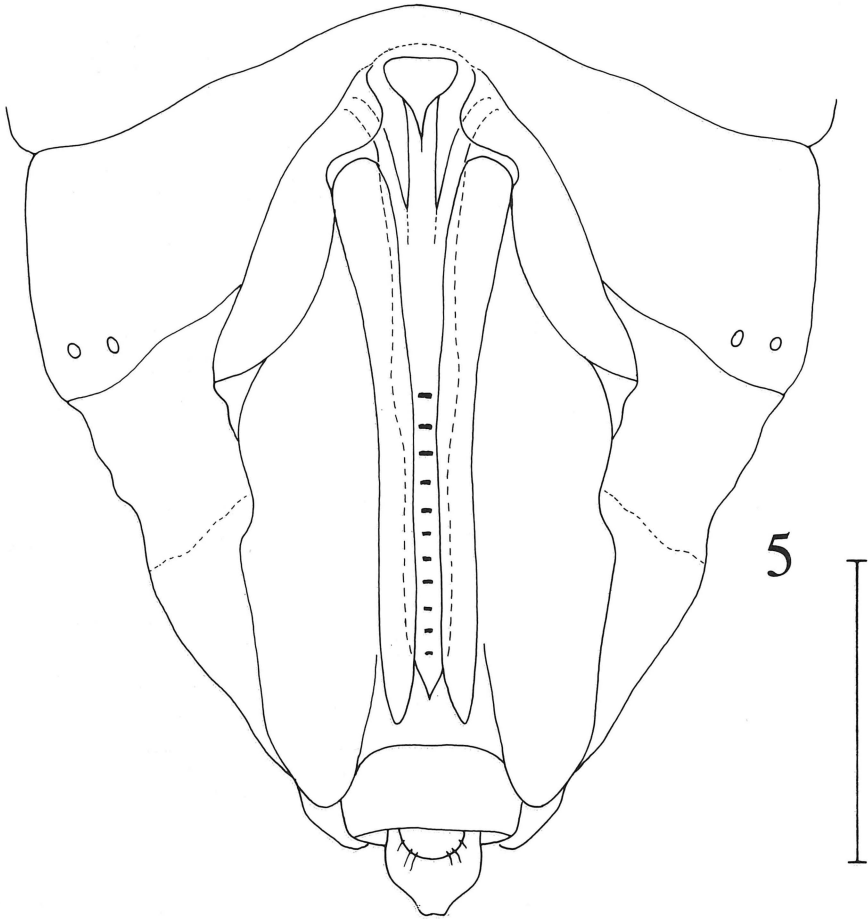


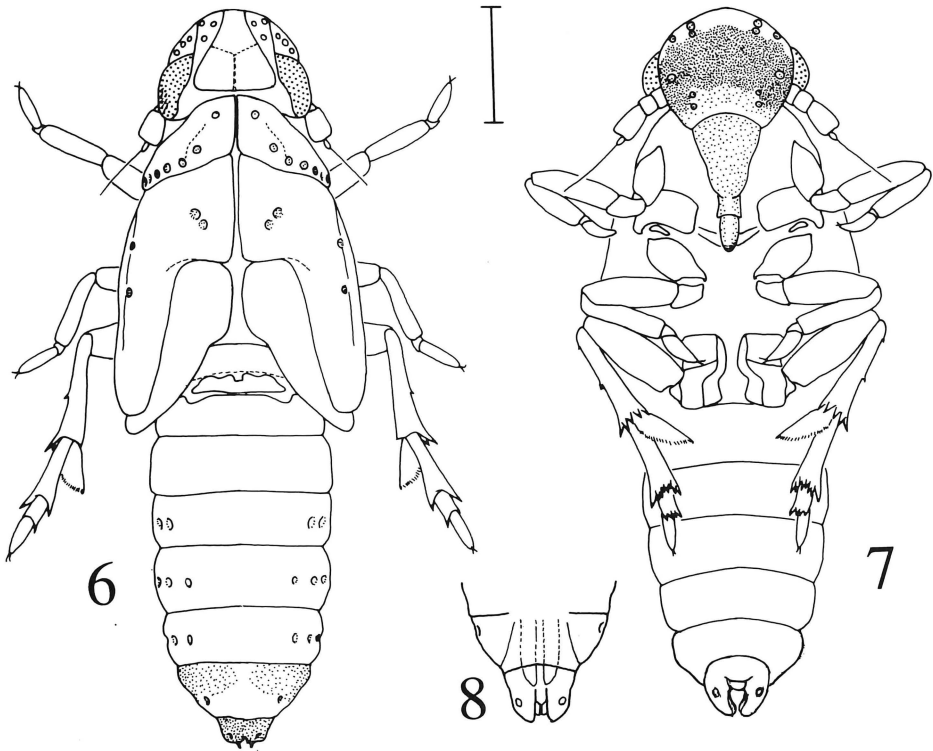
Figure 5. *Eoerysa flavocapitata* female, ventral view of complete genitalia. Scale bar = 0.5 mm.

EOEURYSA FLAVOCAPITATA MUIR

Descriptions.—Adults (Figs. 1–5). Adult *E. flavocapitata* were briefly described by Muir (1913); detailed descriptions and illustrations provided by Jiang (1976) and Yang (1989) should be referred to for non-genitalic adult morphology.

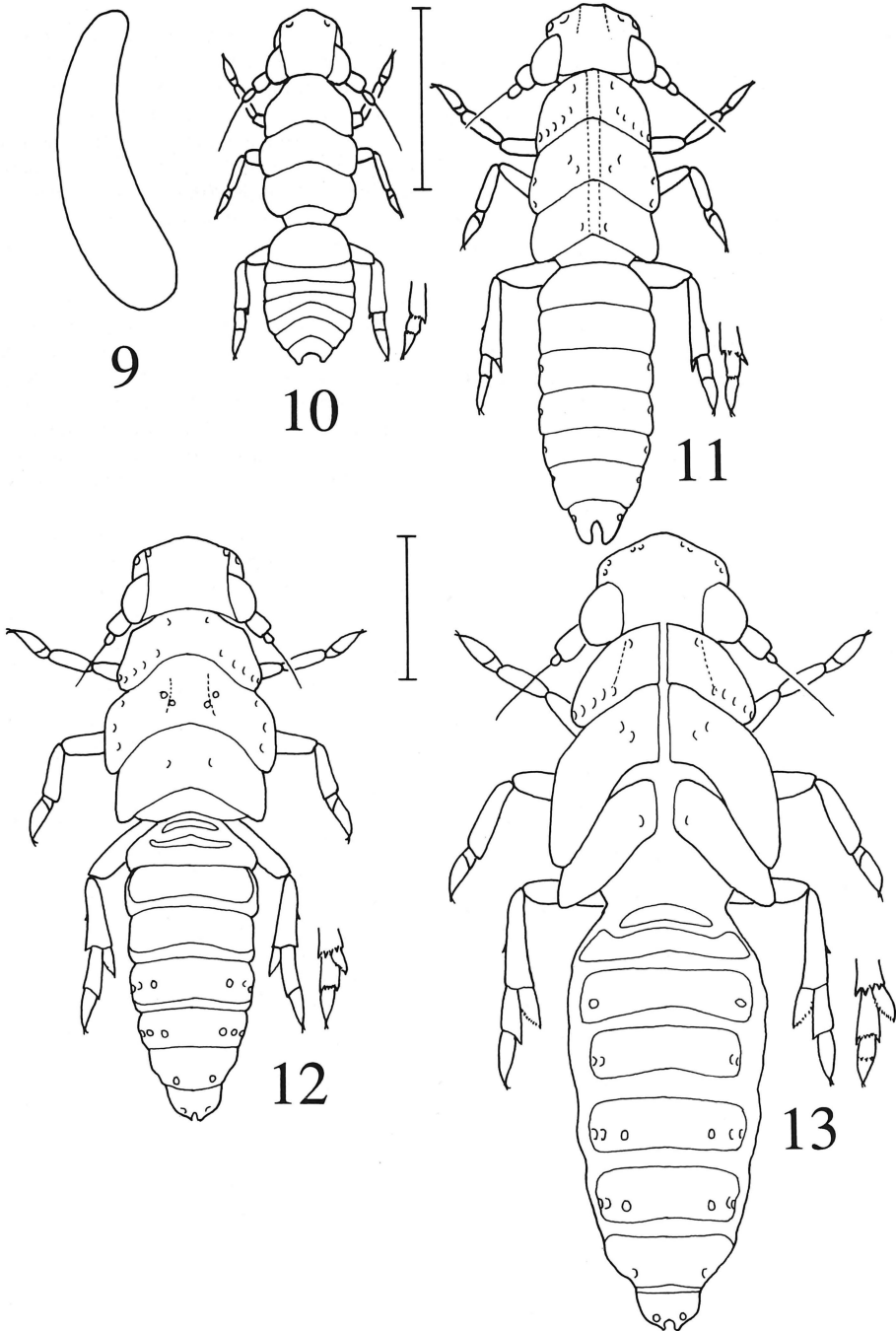
Male genitalia (Figs. 1–3).—Pygofer, in lateral view, subquadrate, with broadly produced diaphragm armature. Anal tube, in lateral view, with a single spinose process originating at the dorsocaudal aspect of the tube, and a pair of bifid spinose processes each originating at the ventrocaudal aspect of the tube. Styles, in caudal view, broadest across basal one-third, narrowing and strongly divergent in apical one-third. Aedeagus subcylindrical, with a dorsally directed terminal bifid tooth and a dorso-caudally directed process in apical one-third on right side.

Female genitalia (Figs. 4, 5).—Tergite nine oriented anteroventrally (see Asche 1985), elongate, longitudinally concave in ventral midline. Anal tube subcylindrical, style somewhat bulbous. Genital scale (or atrium plate) subtriangular. Valvifers of segment eight each covering approximately one-third of tergite nine anterolaterally; medial margin deeply notched in anterior one-third. Lateral gonapophyses of segment nine elongate, broadly rounded posteriorly. In lateral view, median gonapophyses of segment nine saber-shaped, with approximately 15 strong teeth on dorsal margin in distal one-half (not all teeth apparent in ventral view). Gonapophyses of segment eight slender, subacute apically.



Figures 6–8. *Eoerysa flavicapitata* fifth instar. Figure 6. Habitus, dorsal view. Figure 7. Ventral view of male. Figure 8. Apical part of venter of female abdomen. Scale bar = 0.5 mm.

Fifth instar nymph (Figs. 6–8).—Length 3.6 ± 0.17 mm; thoracic length 1.1 ± 0.06 mm; width 1.2 ± 0.08 mm ($n = 10$). Body white with gray to fuscous markings on frons, clypeus, and apex of abdomen. Form elongate, subcylindrical, flattened dorsoventrally, widest across mesothoracic wingpads. Vertex subtriangular; posterior margin nearly straight, narrowing anteriorly. Frons border with clypeus concave; lateral margins strongly convex and carinate (outer carinae) and paralleled by second pair of very weak carinae (inner carinae) continuous with lateral margins of vertex; area between inner and outer carinae with nine pits on each side (six visible in ventral aspect, three in dorsal aspect); three pits between each outer carina and eye. Clypeus subconical, narrowing distally. Beak three-segmented, cylindrical, segment one hidden by anteclypeus, segment two subequal in length to segment three, segment three with black apex. Antennae three-segmented; scape short, cylindrical; pedicel subcylindrical, $2.0 \times$ length of scape; flagellum bulbous basally, with elongate bristle-like extension distally, bulbous base approximately $0.3 \times$ length of pedicel. Thoracic nota divided by middorsal line into three pairs of plates. Pronotal plates subtriangular (in dorsal view); anterior margin convex; posterior border sinuate; each plate with a weak posterolaterally directed carina and seven pits extending anteriorly from near middorsal line posterolaterally to lateral margin (lateralmost pits often not visible in dorsal view). Mesonotum with median length $2.0 \times$ that of pronotum; elongate lobate wingpads almost extending to tips of metanotal wingpads; each plate with very weak posterolaterally directed carina (not illustrated); two pits near middle of non-lobate portion of plate and two pits near lateral margin. Metanotum with median length approximately $0.7 \times$ that of mesonotum; lobate wingpads extending to fourth tergite; each plate with one very weak pit near middle of plate (not illustrated). Pro- and mesocoxae elongated and directed posteromedially; metacoxae fused to sternum. Metatrochanter short and subcylindrical. Metatibia with two spines on lateral aspect of shaft, an apical transverse row of five black-tipped spines on plantar surface and a subtriangular flattened movable spur with one apical tooth and 13–15 other teeth on posterior margin. Pro- and mesotarsi with two



Figures 9–13. *Eoerysa flavocapitata* immature stages. Figure 9. Egg. Figure 10. First instar. Figure 11. Second instar. Figure 12. Third instar. Figure 13. Fourth instar. Scale bars = 0.5 mm (top = 9–11, bottom = 12, 13).

tarsomeres, tarsomere one wedge-shaped; tarsomere two subconical, with pair of apical claws and median membranous pulvillus. Metatarsi with three tarsomeres; tarsomere one with apical transverse row of eight black-tipped spines; tarsomere two cylindrical, approximately 3.5 × length of tarsomere one, with apical transverse row of four black-tipped spines on plantar surface; tarsomere three subconical, slightly longer than tarsomere two, with pair of apical claws and median pulvillus. Abdomen nine segmented; flattened dorsoventrally; widest across fourth abdominal segment. Tergite one small, subtriangular, hidden by juncture of thorax and abdomen (not visible in illustration); two subrectangular, not extending to lateral aspect of segment; tergites five to eight each with three pits on each side (lateralmost pits not always visible in dorsal view). Segment nine surrounding anus, with three pits on each side; female with one pair of acute processes extending from juncture of sternites eight and nine; males lacking processes.

Fourth instar nymph (Fig. 13).—Length 2.8 ± 0.18 mm; thoracic length 0.8 ± 0.04 mm; width 0.08 ± 0.04 mm (n = 10). Antennal flagellum with basal portion approximately 0.5 × length of pedicel. Mesonotal wingpads shorter, each covering approximately two-thirds of metanotal wingpad laterally. Metanotal median length 1.5 × that of mesonotum; wingpad extending to tergite two. Metatibial spur slightly smaller, with one apical tooth and eight teeth on margin. Metatarsi with two tarsomeres; tarsomere one with apical transverse row of seven black-tipped spines; tarsomere two subconical with three black-tipped spines in middle of tarsomere on plantar surface. Abdominal segments four to eight each with the following number of pits on either side of midline: tergite four with one pit, five with two, six to eight each with three, segment nine with three.

Third instar nymph (Fig. 12).—Length 2.0 ± 0.12 mm; thoracic length 0.6 ± 0.02 mm; width 0.6 ± 0.03 mm (n = 10). Mesonotal wingpads shorter, each covering one-third of metanotal wingpad laterally. Metanotal wingpad extending to tergite one. Metatibial spur smaller; with one apical and one or two marginal teeth. Metatarsomere one with apical transverse row of six black-tipped spines on plantar surface.

Second instar nymph (Fig. 11).—Length 1.5 ± 0.06 mm; thoracic length 0.5 ± 0.01 mm; width 0.4 ± 0.02 mm (n = 10). Mesonotal median length subequal to that of pronotum; wingpads undeveloped. Metanotal median length subequal to that of mesonotum; wingpads undeveloped. Metatibia with apical row of three black-tipped spines; spur small with no marginal teeth, approximately 3.0 × length of longest metatibial spine; metatarsomere one with four apical black-tipped spines.

First instar nymph (Fig. 10).—Length 1.0 ± 0.06 mm; thoracic length 0.4 ± 0.02 mm; width 0.3 ± 0.02 mm (n = 10). Bulbous base of antennal flagellum subequal in length to that of pedicel. Metatibia lacking spines on shaft; metatibial spur smaller, approximately 1.5 × length of longest metatibial spine.

Egg (Fig. 9).—Length 0.8 ± 0.05 mm; width 0.2 ± 0.02 mm (n = 5). Eggs laid singly; white, cylindrical, narrower at apical end; chorion translucent, smooth.

Material Examined.—Specimens used for description have the following data: REPUBLIC OF CHINA. TAIWAN: Taichung, 5 Dec 1989, ex sugarcane, (10 males, 12 females, 5 eggs, 19 first instars, 14 second instars, 15 third instars, 25 fourth instars, 19 fifth instars).

Key to *E. flavocapitata* Nymphal Instars

- 1. Metatibial spur with more than five marginal teeth (Figs. 7, 13); mesonotal wingpads overlapping more than one-half length of metanotal wingpads (Figs. 6, 13) 2
- Metatibial spur with fewer than five marginal teeth; mesonotal wingpads overlap less than one-half length of metanotal wingpads (Figs. 10–12) 3
- 2(1). Metatarsi with three tarsomeres; metatibial spur with more than 10 marginal teeth; mesonotal wingpads extending to or almost to apex of metanotal wingpads (Figs. 6, 7) fifth instar
- Metatarsi with two tarsomeres; metatibial spur with eight marginal teeth; mesonotal wingpads not extending to apex of metanotal wingpads (Fig. 13) fourth instar
- 3(2). Metatibia with transverse row of four apical spines, spur with one or two marginal teeth (Fig. 12) third instar

- Metatibia with transverse row of three apical spines, spur lacking marginal teeth (Figs. 10, 11) 4
- 4(3). Metatibia with lateral spine near middle on outer surface; spur approximately $3.0 \times$ length of longest metatibial apical spine (Fig. 11) second instar
- Metatibia without lateral spines; spur approximately $2.0 \times$ or less length of longest metatibial apical spine (Fig. 10) first instar

ACKNOWLEDGMENT

Florida Agricultural Experiment Station Journal Series R-01742.

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Received 24 July 1991; accepted 23 October 1991.

A REDESCRIPTION OF *ORDOBREVIA NUBIFERA* (FALL) (COLEOPTERA: ELMIDAE)

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Abstract.—Newly found variation in the size, sculpturing and color of *Ordobrevia nubifera* (Fall) is described. This variation may be linked to varying larval developmental rates.

Key Words.—Insecta, Coleoptera, Elmidae, *Ordobrevia*, variation, development

The genus *Ordobrevia* was erected in 1953 by Sanderson, with *Stenelmis nubifera* Fall, 1901 as its type species. At that time, *S. nubifera* was the sole member of the “*nubifera* group” of *Stenelmis* (Sanderson 1938). Twelve more species of *Ordobrevia* have been described since 1953. Four are from the Palaearctic region (Japan) and eight are from the Oriental region (Brown 1981). It thus appears that *Ordobrevia nubifera* represents an intrusion of the Palaearctic/Oriental fauna into the Nearctic fauna. *Zaitzevia* (Elmidae) and *Eubrianax* (Psephenidae) show similar intrusions (Brown 1981).

Ordobrevia nubifera occurs only in North America, and its known range extends from California to Washington (Brown 1972). More is known about California populations than those in other areas. Within California, *O. nubifera* occurs widely throughout all the various mountain ranges. It inhabits streams of all sizes from first order to much larger. It seems to prefer microhabitats with faster flows and coarser substrates.

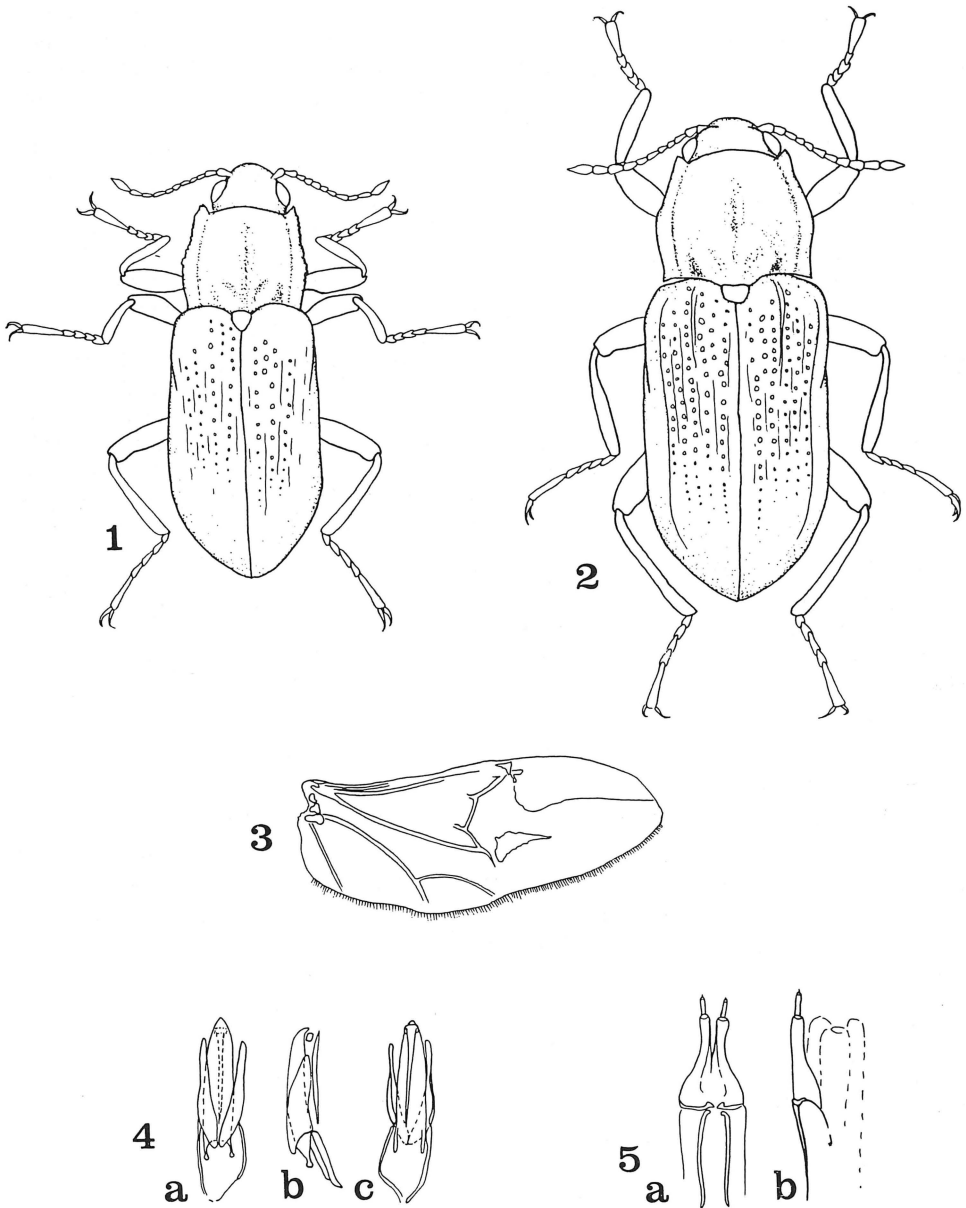
Several years ago I found what seemed to be a new species of *Ordobrevia*. It was larger and more robust, and it had more coarse granulation and a distinctly different color pattern. I came embarrassingly close to describing it as a new species. Subsequent collections have shown it to be the end of a previously unknown range of variation within *O. nubifera*. Recent studies of the elmid fauna of Taiwan by M. L. Jang and P. S. Yang, and an ongoing revision of *Stenelmis* by Kurt Schmude have called into question the status and identity of *Ordobrevia*. Because of these two recent studies and discovery of additional intraspecific variation in *O. nubifera*, I decided to review what was known about *Ordobrevia nubifera*.

Existing work that illustrates *O. nubifera* includes the following: for larvae, ninth abdominal tergum (Sanderson 1953: fig. 24), mesothorax (Leech & Chandler 1956: fig. 13:51h), habitus (Brown 1972: figs. 163 and 164), head (White et al. 1984: fig. 19.246); and for adults, aedeagus (Sanderson 1938: fig. 1), antenna (Sanderson 1938: fig. 7), elytral pattern (Sanderson 1938: fig. 19), elytron (Leech & Chandler 1956: fig. 13:52g), and habitus (Brown 1972: fig. 25, White et al. 1984: fig. 19.272).

ORDOBREVIA NUBIFERA (FALL) 1901

Redescription.—(both sexes, except as indicated).—BODY: Body elongate, slender (Fig. 1) to robust (Fig. 2), parallel sided; sculpturing and granulation slight to very coarse. Pronotum narrower than

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Figures 1–5. *Ordobrevia nubifera*. Figure 1. Typical morph. Figure 2. Large morph. Figure 3. Right wing. Figure 4. Aedeagus (a—dorsal view, b—lateral view, c—ventral view). Figure 5. Ovipositor (a—dorsal view, b—lateral view).

elytra. Body uniformly brown to testaceous, with a transverse yellow band across the middle of the elytra. Length 2.0–2.6 mm; width 0.8–1.2 mm. HEAD: Head covered with granules. Granules longitudinally elongate on the epicranial surface, less elongate elsewhere. Antennal ridges prominent dorsally. Fronto-clypeal suture absent. Clypeus with coarse setae on apical margin. Labrum dark brown, shiny, coriaceous; apical margin with thick medially curved setae. Mandibles prominent; tips trifold. Palpi three-segmented, last segment broad and apically truncate; labial palpi lighter than maxillary palpi. Antennae eleven-segmented; segments one to six narrow; segments seven to eleven apically

widened forming a weakly defined club, possessing lateral tufts of whitish setae. PRONOTUM: Pronotum usually wider than long, width greatest just behind middle. Base of pronotum wider than apex, lateral margins sinuate and weakly serrate. Entire surface covered with close-set granules and punctures. Median longitudinal sulcus in basal three-fourths of pronotum; sulcus deeper anteriorly. Base of median sulcus with two depressions on each side. ELYTRA: Elytra with punctae arranged in striae. Punctures smaller and less distinct in apical one-third, obsolete at tip. Surface between punctures smooth and shiny to coarsely granulate. First and accessory striae join in basal one-fourth. Intervals raised; third intervals carinate in basal third; sixth intervals forming sublateral carinae that reach almost to apex. Humeri distinct and produced beyond basal pronotal margins. Epipleura extend almost to tip of elytra. WINGS: Wings entire (Fig. 3); posterior edge with fringe of fine setae. Venation reduced. VENTER: Hypomera, pro-, meso-, and metasternum covered with granules separated by less than their own width. Prosternal margin projecting anteriorly under head and labium. Prosternal process parallel-sided, projecting beyond coxae, with apex apically rounded. Mesosternum very short, broadly truncate apically, reaching only to middle of mesocoxae; median longitudinal sulcus present. Metasternum similar to mesosternum but longer, with apex broadly emarginate. Abdomen with five visible segments; males with segment V with lateral margins produced into short wide spines and narrowly emarginate apically; females with lateral margins only weakly spiniform and apex broadly emarginate. Granules on segment I rounded, separated by own width, those on segments II-V elongate, more widely separated. All segments with lateral flanges closely fitting into the epipleura. LEGS: Pro- and mesocoxae rounded, metacoxae transverse. Metathoracic legs slightly longer than others. Granules on coxae rounded, close-set. Granules on trochanters $2.0\times$ as long as wide. Granules on femora and tibiae very elongate, arranged parallel to the axes of the legs. GENITALIA: Male genitalia (Fig. 4) with parameres shorter than median piece; accessory sclerites include a longitudinally elongate ventral sclerite and a short transverse rectangular sclerite located between the tips of the median piece and the ventral piece; basal piece weakly sclerotized, varying from a flattened U-shape to a complete ring. Female genitalia (Fig. 5) typical for elmids.

DISCUSSION

This species shows considerably more size variation than previously stated. However, I think that size ranges given in the literature are often the result of repetition of earlier measurements that may have been based on relatively few specimens. The morph that I earlier almost mistook for a new species is now considered to be the upper range of size for *O. nubifera*. It is longer and much wider than "typical" specimens. A more strongly developed granulation, punctation and sculpturing, and a trend toward uniformly dark brown color is correlated with increasing size. Other morphologic characters remain unchanged, albeit somewhat larger in proportions.

There seem to be higher percentages of larger individuals of *Ordobrevia nubifera* in populations in the northern Coastal Mountains and the Warner Mountains than in other parts of California (unpublished data). These larger individuals of *O. nubifera* often occur with "typical" specimens. However, the larger morph is a larger percentage of the population in rather cold streams, or in areas that experience rather cold winter weather. I now think that they represent larvae in which the normal developmental rate was retarded allowing the normal growth rate to produce a larger-than-normal individual. Larger larvae, of course, mean larger adults. Differential manipulation of developmental rates has been shown to cause different sized morphs in the worker caste of ants (Oster & Wilson 1978). I have found similar, larger-than-normal individuals in several other elmid genera. Retardation of developmental rates could be a result of intrinsic factors (e.g., genetic recombinations, random mutations) or extrinsic factors (e.g., cold temperatures, limited supplies of specific nutrients). My experiences lead me to favor the cold temperatures as the major influencing factor. Some described variations

in *Microcylloepus*, another elmids, appear to be temperature correlated (Shepard 1990). However, in this case, smaller-than-normal individuals (and species) occur in warmer habitats. There, I believe, the developmental rate is accelerated while the growth rate remains unaffected. Thus the individuals mature at a smaller body size. More study is warranted concerning the influences of varying temperatures upon life cycle events in natural populations.

My near description of a new species of *Ordobrevia* should alert other taxonomists to sample extensively and pay more attention to intraspecific variation. Even though I had previously collected and identified hundreds of the "typical" *O. nubifera*, I did not have an accurate idea of the total intraspecific variation until I collected in streams that were perennially cold, or were very cold during large parts of the year. I am also reminded of the necessity of obtaining population samples large enough to contain the rarer morphs within a population. This is especially a problem when sampling aquatic insects in such an ecologically diverse area as California. Larger population samples have led me to question the validity of several California elmids species.

ACKNOWLEDGMENT

Harley P. Brown kindly loaned specimens from his collection for this study, and generously offered his comments on the manuscript. Part of this study was supported by a summer research position at the University of Oklahoma Biological Station.

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Received 25 June 1991; accepted 1 November 1991.

A REVIEW OF THE SWEETPOTATO WHITEFLY IN SOUTHERN CALIFORNIA

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Abstract.—The sweetpotato whitefly, *Bemisia tabaci* Gennadius, of Palearctic origin was originally introduced into California in the late 1920s. Since that time it has been restricted to the state's southern desert valleys and has, at times, been a significant agricultural problem. In the mid-1980s, however, a new "strain" of *B. tabaci* was introduced to southern California and has wreaked great havoc in the area. This strain, from poinsettia plants, has become known as the B strain, poinsettia strain or poinsettia whitefly. This paper documents the new introduction, notes the poinsettia strain's differences from other *B. tabaci*, and assesses the possibilities for its control.

Key Words.—Insecta, Aleyrodidae, *Bemisia tabaci*, sweetpotato whitefly, California

California has been experiencing serious problems with whiteflies during the last several years. Of the approximately 1160 described species of whiteflies in the world, 54 occur in the state along with approximately a dozen undescribed native species. Of California's described species, at least 11 were introduced by man's activities, and five have been introduced in the last 15 years. Several of the introduced species have become serious pests and two are currently quite problematic: the ash whitefly, *Siphoninus phillyreae* (Haliday), and the sweetpotato whitefly, *Bemisia tabaci* (Gennadius). These species currently have extremely large populations in areas of California.

The ash whitefly, an easily recognized species, was introduced into the state in the late 1980s, and although it spread rapidly with tremendous population explosions (Sorensen et al. 1991), a successful parasite was found (Bellows et al. 1991) and effective biological control has progressed rapidly. The sweetpotato whitefly (SPW), however, has been in California since the 1920s (Russell 1975), but only in the last two decades, particularly the early 1980s, has it been a serious agricultural problem (Natwick & Zalom 1984) and a taxonomic and ecological curiosity. Currently, it is in a disastrous expansion phase in southern California, which involves the acquisition of many new hosts. This paper documents the ecological history and potential taxonomic problems with SPW in southern California.

BACKGROUND

The *Bemisia tabaci* was originally described as an *Aleyrodes* from tobacco in Greece in 1889 (Gennadius 1889). Since then, the species has been redescribed in synonymy many times (Table 1). The insect has spread to most tropical and subtropical areas of the globe, occasionally causing serious damage upon colonization. It was first recorded from India in 1905 (Misra & Lamba 1929, Reddy & Rao 1989, Immaraju 1989), and by 1919 had become a serious pest of cotton in the Punjab (now Pakistan) (Immaraju 1989). It has been reported as a serious

Table 1. Taxonomic synonyms of sweetpotato whitefly.^a

Genus	Species	Author	Date	Type locality
<i>Aleyrodes</i>	<i>tabaci</i>	Gennadius	1889	Greece
<i>Aleyrodes</i>	<i>inconspicua</i>	Quaintance	1900	Florida
<i>Bemisia</i>	<i>emiliae</i>	Corbett	1926	Sri Lanka
<i>Bemisia</i>	<i>costa-limai</i>	Bondar	1928	Brazil
<i>Bemisia</i>	<i>signata</i>	Bondar	1928	Brazil
<i>Bemisia</i>	<i>bahiana</i>	Bondar	1928	Brazil
<i>Bemisia</i>	<i>gossypiperda</i>	Misra & Lambda	1929	Pakistan
<i>Bemisia</i>	<i>acyranthes</i>	Singh	1931	Pakistan
<i>Bemisia</i>	<i>hibisci</i>	Takahashi	1933	Taiwan
<i>Bemisia</i>	<i>longispina</i>	Priesner & Hosny	1934	Egypt
<i>Bemisia</i>	<i>gossypiperda</i> var. <i>mosaicaivectura</i>	Ghesquiere	1934	Zaire
<i>Bemisia</i>	<i>goldingi</i>	Corbett	1935	Nigeria
<i>Bemisia</i>	<i>nigeriensis</i>	Corbett	1935	Nigeria
<i>Bemisia</i>	<i>rhodesiaensis</i>	Corbett	1936	Rhodesia
<i>Bemisia</i>	<i>manihotis</i>	Frappa	1938	Madagascar
<i>Bemisia</i>	<i>vassyierei</i>	Frappa	1939	Madagascar
<i>Bemisia</i>	<i>lonicerae</i>	Takahashi	1957	Japan
<i>Bemisia</i>	<i>minima</i>	Danzig	1964	U.S.S.R.
<i>Bemisia</i>	<i>miniscula</i>	Danzig	1964	U.S.S.R.

^a See Taxonomic Assessment and Biological Control section for comments on *B. poinsettiae* Hempel, 1923.

pest of various crops in: the West Indies, Nicaragua, Venezuela, Brazil, Turkey, Israel, Egypt, Sudan, Iran, Thailand, and the Philippines. In addition, it is known from southern Europe, the Middle East, much of Africa, Madagascar, Sri Lanka, China, Malaya, Australia, New Guinea, Fiji, and Hawaii, among other locations. By 1978, SPW was known from at least 420 plant species in 18 families (Mound & Halsey 1978, Greathead 1986), but new hosts are being continually added as the current infestation in California and Arizona grows. Currently, SPW is a major economic pest of cotton, tobacco, cassava, sweetpotato and soy bean in many areas of the world.

After its introduction to the U.S., SPW was redescribed as *Bemisia inconspicua* by A. L. Quaintance (1900) from material collected on okra and sweetpotato in Florida between 1897 and 1898. Later, museum specimens were found to have been collected in Pomona, Putnam County, Florida in 1894 (Russell 1975). It has since spread across the southern part of the U.S. Prior to 1985, it was found in outdoor environments in Florida, Georgia, Texas, Arizona and California. Recently, it has been found in extremely high populations in the agricultural areas of Arizona, California, Texas and northwestern Mexico.

HISTORY IN CALIFORNIA

Specimen records at the U.S. National Museum of Natural History indicate it had been introduced into California by at least 1928 (Russell 1975), when it was collected on cotton at Calipatria, Imperial County. Subsequent records of early spread in California are shown in Table 2. Although SPW was in California in the late 1920s, it was found outdoors only in the desert valleys of Imperial,

Table 2. The earliest records of the spread of *Bemisia tabaci* within California, after its 1928 introduction (Calipatria, Imperial Co.) on cotton.

Year	County	Location	Host
1947	Riverside Co.	Coachella	sweetpotato
1950-1954	Riverside Co.	Indio	cotton
1951	Imperial Co.	Calexico	cotton
1952	Riverside Co.	Coachella	cotton
1953	Riverside Co.	Thermal	sweetpotato
1953	Riverside Co.	Mecca	sweetpotato
1954	Imperial Co.	Imperial	cotton
1954	Riverside Co.	Riverside	cotton ^a
1955	Riverside Co.	Riverside	euphorbia ^a
1961	San Bernardino Co.	Yucca Valley	<i>Hibiscus</i> sp.

^a In greenhouse.

Riverside, San Bernardino and San Diego Counties. It was seldom, if ever, found in greenhouses in California, and then usually on plants imported recently from other states.

In the Imperial Valley of California, a curious and disastrous phenomenon occurred with SPW in the summer and fall of 1981; its populations exploded on numerous crops, including cotton, melons and lettuce. D-Vac[®] monitoring by University of California Agricultural Extension personnel collected over 60,000 whiteflies per 100 sweeps of the devices (Natwick & Leigh 1984). The large numbers of whiteflies were severely debilitating the infested crops, and also transmitting serious viral diseases to the crops. High incidences of squash yellow leaf curl and lettuce infectious yellows resulted in premature plow-down and total crop loss in many lettuce and melon fields in fall 1981 (Duffus & Flock 1982, Natwick & Zalom 1984).

Although 1981 was a disastrous year for the growers in the Imperial, Bard and Palo Verde Valleys of California, SPW had actually been building up populations over the preceding several years. University of California extension personnel had been making routine whitefly counts for many years (Natwick & Leigh 1984) because SPW and another species, banded-winged whitefly [*Trialeurodes abutiloneus* (Haldeman)] were found on cotton infested with cotton leaf crumple, a viral disease. Prior to 1975, D-Vac[®] catches for SPW were running consistently lower than 300-400 per 100 sweeps. However, in 1975 the number jumped to nearly 4300 whiteflies per 100 sweeps. Numbers dropped the next year, only to leap to an incredible 35,000 whiteflies per 100 sweeps in 1977. The populations dropped again to near zero in 1978, only to be followed by the disastrous rebound seen in 1981.

There are several possible causes for these population explosions, which probably result from several interrelated concurrent events. Starting in 1975, the southern California desert areas experienced unusually warm winter temperatures, with a virtual absence of days below freezing (only two years out of nine had recorded temperatures below 0° C) (Flock & Christopherson 1985). Because SPW is apparently of tropical origin, cool or cold temperatures appear to prevent normal development, while high summer temperatures and humidity probably enhance development. Comparing the warm winter temperature ranges in the Imperial

Valley with the sudden upsurges observed in SPW populations shows an intriguing, yet not exactly corresponding, correlation.

A second event in the Imperial Valley area in 1975 involved the first use there of synthetic pyrethroid insecticides for general pest control (E. T. Natwick, personal communication). Such pyrethroids have a devastating effect on the natural enemies (primarily parasitoids) of SPW. Essentially the lack of cold winter temperatures allowed SPW to maintain larger than normal populations through the winter, and a reduced natural enemy population allowed SPW an unencumbered pathway to the devastating populations that were encountered between 1975 and 1990. By 1986, researchers and growers were discovering ways to deal with the SPW problem. They observed that the SPW population was building up on cotton to such large levels that by the time the cotton was ready for the normal fall defoliation and harvest, it would be heavily covered with honeydew and sooty mold. When the cotton was defoliated, the whiteflies would move in large numbers into other crops including squash, melons, lettuce, sugar beets, tomatoes and other specialty crops, transmitting viral diseases presumably picked up from weeds and other virus infected hosts. By defoliating cotton early, it was found that SPW did not have time to develop large populations that could move onto other crops, and the cotton would be fairly free of honeydew and sooty mold (Meyerdirk et al. 1986).

By 1990, just when the SPW problem seemed to be under control in the desert southwest, a second disastrous phenomenon occurred, this time as a result of events in Florida four years earlier. SPW had maintained a foothold in Florida for many years, seldom being more than a scientific curiosity. Inexplicably in 1986, growers of greenhouse poinsettias had a devastating outbreak of SPW that appeared overly resistant to chemical control (Hamon & Salguero 1987). As the summer of 1986 wore on, these SPW jumped to numerous other greenhouse bedding plants and nursery stock; they also began infesting outdoor vegetable crops and gardens with disastrous results. By 1987, the large poinsettia nurseries of San Diego County were found to be infested, and over the next year or two SPW was found on poinsettias in many greenhouses throughout California. Shortly thereafter, in late 1990, SPW moderately infested commercial citrus groves near Phoenix, Arizona; it had never been found on this crop in economically damaging populations before (D. N. Byrne, personal communication). SPW was observed to spend the winter in fairly large numbers on this plant.

Prior to the find of SPW on citrus, researchers in Florida and Arizona were beginning to evaluate some of the characteristics and effects of the SPW "strain" (hereafter referred to as poinsettia SPW) that began attacking greenhouse poinsettias and other crops in Florida in 1986. Poinsettia SPW was found to cause virus-like symptoms in cucurbits (Yokomi et al. 1990; Costa & Brown 1990, 1991a, b) that were quickly called "squash silver leaf." These symptoms probably are related to a phytotoxin injected into the plant by poinsettia SPW, because the plants recovered from the effects when the whiteflies were removed.

In contrast, it was found that the original "strain" of SPW (hereafter referred to as cotton SPW) reared from cotton, squash and other crops in Arizona (Costa & Brown 1990, 1991) and California (Perring et al. 1991) did not produce these same symptoms in squash plants. Shortly thereafter, researchers in Arizona (Costa & Brown 1990, 1991) and California (Perring et al. 1991) investigated the isozymic

variation in poinsettia versus cotton SPW "strains" using several different electrophoretic techniques. Populations of poinsettia SPW from poinsettias were found to show slight, but consistently different, esterase banding patterns from those cotton SPW populations that had existed in the southwest prior to 1986. Taxonomists, however, have not been able yet to show a morphological difference between these populations, and they are both currently considered to be *B. tabaci*.

After SPW was discovered on citrus in Arizona, it was assayed using electrophoretic techniques and found to be poinsettia SPW (D. N. Byrne, personal communication). By early spring 1991, it became evident that SPW was occurring in large numbers over the winter on cole crops, particularly broccoli, in the Yuma and Imperial Valleys; the presence of SPW on cole crops in winter had never been experienced in these areas before. These whiteflies also were determined to be poinsettia SPW (T. M. Perring, personal communication).

By July 1991, it was obvious that a major and catastrophic change had taken place in the SPW situation in the Imperial and Palo Verde Valleys (Weddle & Carson 1991, Perring et al. 1991). Observers in the field made many startling discoveries. Some cotton was covered completely by adult whiteflies before the plants could produce more than three or four leaves. The first leaves of squash plants were being devastated before the plants could send out three or four inches of runners. Many fields were disced under. The cotton that did mature was hopelessly sticky with honeydew before the bolls could open. Fields of alfalfa were so sticky they could not be baled. In late August, table grape vineyards on the north shore of the Salton Sea in Riverside County were found heavily infested and sticky with SPW. The same was found on new growth of grapefruit plantings and on many weed species in the immediate vicinity. Some of this infestation apparently originated from clouds of SPW that have been observed flying across the Salton Sea from breeding grounds in the Imperial Valley. These whiteflies are generally considered to be the poinsettia SPW.

After just one season, cotton SPW is now believed to be practically nonexistent in California (T. M. Perring, personal communication), due either to interbreeding, competition between the two strains, the extreme cold temperatures of December 1990, or possibly all of these reasons. Cross breeding experiments that are now being conducted in Arizona and California may shed light on this phenomenon. However, work that had been done on the two strains prior to this summer has also produced some other interesting differences between the two SPW strains. Poinsettia SPW is more cold tolerant. The time required to complete a generation has been found to be slightly shorter in poinsettia SPW, or identical in the two strains (usually 16–23 days), but poinsettia SPW is considered to be five times as prolific (T. M. Perring, personal communication). Poinsettia SPW has been found to extract five times as much nutrient material from plants and, therefore, produces five times as much honeydew as cotton SPW. Although cotton SPW is thought to be a better virus disease vector, at least with lettuce infectious yellows (J. E. Duffus, personal communication), poinsettia SPW has produced such large populations that plants die before virus symptoms appear (F. Laemmlin, personal communication), so its effectiveness in virus transmission is unknown. Furthermore, poinsettia SPW severely attacks more crops, including some not previously utilized by cotton SPW.

By the first week in October 1991, SPW had been found in moderate numbers in dooryard vegetable gardens in the city of San Bernardino. This is the first

important record for any SPW outdoors in California outside of the desert valleys. One week later, SPW was found on established, outdoor poinsettia bushes in Riverside, Riverside County. The owners of these bushes said that the whiteflies had been a problem since the previous year. By December, SPW had been found in three southern San Joaquin Valley counties in field situations not associated with nurseries.

TAXONOMIC ASSESSMENTS AND BIOLOGICAL CONTROL

As was done with ash whitefly, the first step that should be taken to find an effective biological control for SPW is to identify the native home of the insect, so that natural enemies can be found. In the case of SPW, however, this creates an immediate dilemma. Up until recently, the native home of SPW was thought to be either the Orient or Africa/the Middle East (Mound 1963, Lopez-Avila 1986, Anonymous 1987). Other *Bemisia* are prevalent in southern Russia and are also known from mainland Asia, southeast Asia along the Pacific rim, Africa, and one species each from South America and the western United States (Mound & Halsey 1978). Certainly, the area to the north and west of Pakistan shows the greatest diversity in parasitoids of *Bemisia* (Mound & Halsey 1978, N. Mills 1992), reputedly an indication of a genus epicenter.

SPW was probably moved around the world at a very early date, but was not described until 1889. Because SPW has probably been reintroduced into many countries numerous times, it becomes extremely difficult to trace the origin of the whitefly. Because poinsettia and cotton SPW cannot presently be separated morphologically, we cannot effectively access pre-1986 museum specimens to ascertain where poinsettia SPW occurred prior to 1986. Lacking adequate surveys using electrophoretic analysis to separate the strains, we so far have very limited knowledge of where poinsettia SPW presently occurs in the world. We know only that it has been transported over most of the U.S. and the Caribbean on poinsettia and other nursery crops (J. K. Brown, personal communication). It has also been transported to Canadian greenhouses (Broadbent et al. 1989), from where it escaped to the field but probably could not survive the Canadian winters.

Recently, however, evidence is emerging that indicates *B. tabaci* may be of New World origin. For example, it seems to do best on hosts that are of New World origin (unpublished data), such as sweetpotato, poinsettia, tomato, common bean, squash, peppers, and tobacco. Further, in Puerto Rico (Bird 1957), a strain of *B. tabaci* was identified that feed solely on *Jatropha gossypifolia* L., a plant of New World origin, despite numerous trials on other hosts; a feeding pattern that seems highly unlikely if *B. tabaci* were of Old World origin. A New World origin hypothesis for *B. tabaci* would have important ramifications for searching for natural enemies, switching the search emphasis to the Neotropics.

New studies of genetic variance may also suggest a New World origin for *B. tabaci*. Wool et al. (1991) examined isozymes of *B. tabaci* populations in Israel and found genetic uniformity, with no geographical races existing there. However, in examining *B. tabaci* from Columbia, they found differing esterase patterns among populations from various Columbian regions. In fact, the esterase pattern found in samples from the Valle, near Cali, were "very similar to the Israeli pattern" (Wool et al. 1991: 228). Similar circumstances exist in other homopterans, suggesting that centers of origin for a species probably have higher genetic

variability than do invaded areas. For example, among now cosmopolitan aphids, such as *Myzus persicae* (Sulzer) and *Macrosiphum euphorbiae* (Thomas), electrophoretic surveys of variance in North America indicate that the former, with zero variability in the Nearctic, probably had a limited introduction to that continent, whereas the latter, with a higher heterozygosity level, is probably a Nearctic endemic (May & Holbrook 1978).

This limited "founder effect" variance appears contrary to implied increasing genetic variance in other invasive whiteflies, such as *Siphoninus phillyreae* recently in California, where Sorensen et al. (1991) proposed a mutation-driven expansion of feeding-range, caused by explosive invasive populations in the absence of population controls. (A situation also similar to poinsettia SPW there.) Clearly, electrophoretic surveys of *S. phillyreae* in California should be (or *should have been*) conducted to monitor its heterozygosity during the geographical expansion. If limited genetic variability were maintained for *S. phillyreae* during its California explosion, then theories of expansions in the range of host-feeding during invasions might require modification (J. T. Sorensen, personal communication).

SPW, like several other whiteflies and scale insects, tends to be morphologically variable depending on both its host and on its location on the plant (Mound 1963). In SPW, the last stage nymph ("pupa") usually has a smooth dorsal surface if the host leaf is smooth. Alternatively, if the underside of the host leaf is covered with stiff hairs or spines, the pupa usually possesses very long (usually two to eight) dorsal setae arising on the head, thorax and abdominal areas. The pupa also tends to develop other unique characteristics on given hosts, as has been demonstrated by cross-rearing various populations on different hosts. Before interhost morphological variability was realized, numerous *Bemisia* synonyms were described as distinct species, but are now considered to be *B. tabaci* (Russell 1957) (Table 1).

Partly because of host induced morphological variation, conventional taxonomists have not been able to find characters in any of the life stages of SPW that would indicate that more than one species is present. Current diagnostic methods require either live insects to test for the ability to induce squash silver leaf symptoms, or adults that have been adequately preserved for electrophoretic analysis.

What poinsettia SPW actually represents remains in question. Because no differentiating morphological traits have been found it must currently be considered to be the same species as cotton SPW, *B. tabaci*. Yet its explosive population growth and host acquisitions in the presence of cotton SPW suggest that it probably represents something more than a simple biotype, perhaps a sibling species. (Interestingly, type material of *Bemisia poinsettiae* Hempel, 1923, described from Brazil on *Poinsettia* [obtained by E. Delfosse], shows no conventionally used morphological characters that can be used to separate it from *B. tabaci*, with which it thus may be synonymous.) Although there are a few taxonomic tools that are still available to use (e.g., morphometric multivariate analyses), it may take a while before they can be adequately developed on this problem. However, even if we can satisfactorily determine the relationships between the two SPW "strains," we will still require satisfactory control measures. Cotton SPW caused as much as \$100 million in agricultural losses in southeastern California in 1981 (Duffus & Flock 1982). With recent developments, losses in 1991 may go well beyond that mark, because now crops are being attacked that were not infested previously.

ACKNOWLEDGMENT

I thank J. K. Brown, D. N. Byrne, E. Delfosse, J. E. Duffus, F. Laemmlin, N. Mills, E. T. Natwick, and T. M. Perring for providing information used in this review. John T. Sorensen also provided information, and expanded parts of the last section of the article in galley.

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Received 1 November 1991; accepted 26 November 1991.

Scientific Note

A NEW ANT INTRODUCTION FOR NORTH AMERICA: *PHEIDOLE TENERIFFANA* (FOREL) (HYMENOPTERA: FORMICIDAE)

During the spring of 1989, while spraying weeds at Admiral Kidd Park in western Long Beach, California, I discovered several foraging columns of small brown ants. The ants were nesting in the southeastern corner of the park, in sandy soil. I was able to identify the ants to the genus *Pheidole*; later, I sent samples to the Departments of Agriculture in Orange and Los Angeles counties, the California Department of Food & Agriculture, and the Los Angeles County Natural History Museum. Ultimately, the ants were identified to species as *Pheidole teneriffana* (Forel) on 20 Feb 1990 by E. O. Wilson of Harvard University. This species, a native of north Africa and the Canary Islands, has never been recorded from North America, although it had been previously found in Cuba in 1932 (Aguayo, T. 1932. Bull. Brooklyn Entomol. Soc., 22: 219). Between 1989 and 1991, this ant had spread to infest about five acres of the seven acre park site where it was discovered.

The workers of *P. teneriffana* are 2.5 mm long, with a black-brown head and gaster, and a lighter brown thorax. Soldiers of the species have oversized heads with powerful mandibles, and are the same colors as the workers, but larger and 3.75 mm long. The queen is entirely a shining dark brown, and 5.5 to 6.0 mm long, while males are dull light brown to medium brown and 4.0 to 4.5 mm long. The main function of the soldiers is to defend the nest, although both they and the workers will fight with other ants over food or when they are invading new territory.

In Admiral Kidd Park, I have observed on several occasions *P. teneriffana* displacing the Argentine ant, *Iridomyrex humilis* Mayr, another introduced pest species. Between 13 Mar and 5 Jun 1990, and on 9 Sep 1991, *P. teneriffana* advanced into Argentine ant territories, attacking and destroying colonies and taking over their nest sites. Similar interactions have been observed between *Iridomyrex humilis*, and another *Pheidole* sp., *P. megacephala* (Fabr.), in Hawaii and Bermuda (Haskins, C. P. & E. F. Haskins. 1965. Ecology, 46: 736-740; Crowell, K. L. 1968. Ecology, 49: 551-555; Fluker, S. S. & J. W. Beardsley. 1970. Ann. Entomol. Soc. Am., 63: 1290-1296).

In contrast, in the park, a native fire ant, *Solenopsis xyloni* McCook, often raids the nests of *P. teneriffana* and may annihilate whole colonies. Curiously, however, *S. xyloni* is itself displaced, at least partially, by *I. humilis*, so that a repetitious cycle of displacement might occur. It may be possible that *I. humilis* is repelled by a kariomone produced by *P. teneriffana*, but which does not repel *S. xyloni*; whereas, *S. xyloni* might be repelled by a kariomone produced by *I. humilis*?

Pheidole teneriffana seems to have few "conflicts" with less aggressive native ants in the park, but I have observed it attacking workers of the California red harvester ant, *Pogonomyrmex californicus* Buckley. Other ant species present in

the park are: *Conomyrma bicolor* Wheeler, *Conomymra insana* Buckley, *Tapi-noma sessile* Say, *Formica pilicornis* Emery, *Monomorium minimum* Buckley and *Cardiocondyla ectopia* Snelling.

Pheidole teneriffana nests have many inseminated queens; 23 were observed in one colony that was changing its nest site. The nests occur as large colonies with low mounds in the soil, along curbs or sidewalks, at the edges of lawns, in cracks in pavement, and at the bases of trees. New colonies are started by budding, with new queens mating in the nest and moving with part of the existing colony to form new nests in adjacent territory. The workers forage night and day, unless it gets too hot ($>26^{\circ}\text{C}$). However, if the nest is in a shady location, they will remain active on the hottest days. Colony members are predacious on live insects, such as noctuid or beetle larvae. They may also harvest seeds and scavenge dead or dying insects. I have not observed them tending aphids, but they do feed on sweet or greasy materials.

Records.—CALIFORNIA. LOS ANGELES Co.: Long Beach, Admiral Kidd Park, 7 Mar 1989, M. J. Martinez.

Acknowledgment.—I thank Edward O. Wilson, Harvard University, for the determination of this ant to species, and Roy Snelling, Los Angeles County Natural History Museum, for his assistance and support in identifying the ants. I also thank Phil Hester and his staff of the Recreation and Marine Department, Park Bureau, Long Beach Parks, for their cooperation, and my wife, Charlean, for her help and patience.

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Received 30 September 1991; accepted 10 October 1991.

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THE PAN-PACIFIC ENTOMOLOGIST

Volume 68

April 1992

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